MAY 04 1994 Sta. 21 (20)

ENGINEERING DATA TRANSMITTAL

0036258

1. EDT 600039

2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) Liquid Waste Disposal Safety	4. Related EDT No.:
5. Proj./Prog./Dept./Div.: 222-S Laboratory Facility	6. Cog. Engr.: Jay C. Lavender	7. Purchase Order No.: N/A
8. Originator Remarks: The attached document is the Interim Safety Basis (ISB) for the 222-S Laboratory Facility. This document needs to be delivered to RL by October 15, 1993.		9. Equip./Component No.: N/A 10. System/Bldg./Facility: 222-S Laboratory Facility
11. Receiver Remarks:		12. Major Assm. Dwg. No.: N/A 13. Permit/Permit Application No.: N/A 14. Required Response Date:

MAY 1994 RECEIVED EPIC

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Impact Level	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	WHC-SD-CP-ISB-002		0	222-S Laboratory Interim Safety Basis, ~~Phase IIe~~ 12/9/93	2ESQ	1	1	

16. KEY

Impact Level (F)	Reason for Transmittal (G)	Disposition (H) & (I)
1, 2, 3, or 4 (see MRP 5.43)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Impact Level for required signatures)

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.
4,1	1	Cog.Eng. J. C. Lavender		9/25/93		D. M. Busche		5/3/94	L4-74	4,1	1
4,1	1	Cog. Mgr. L. E. Johnson		9/25/93	H4-70	R. P. Marshall			T6-12	4,1	1
4,1	1	QA D. G. Farwick		5/2/94	H4-16	L. L. Weaver		5-2-94	T6-12	4,1	1
4,1	1	Safety ~~E. G. Hess~~ J.C. Hamrick			~~H4-09~~ T4-18	J. J. Zimmer		5-2-94	H4-67	4,1	1
4,1	1	Env. ~~W. R. Brown~~ M.J. Hall		5/02/94	~~H6-30~~ T6-07	SEAC: R. J. Cash		5/3/94	R2-78	4,1	1
4,1	1	M. L. Bell			T6-12						
4,1	1	~~S. L. Brey~~ W.D. Leggett			~~T6-12~~ T6-07						

18. J. C. Lavender 9/25/93 Signature of EDT Originator Date	19. Authorized Representative Date for Receiving Organization	20. L. E. Johnson 9/25/93 Cognizant/Project Engineer's Manager Date	21. DOE APPROVAL (if required) Ltr. No. [] Approved [] Approved w/comments [] Disapproved w/comments

BD-7400-172-2 (07/91) GEF097

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Unclassified Category UC-

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Larry E. Johnson 5/3/94

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SUPPORTING DOCUMENT

SUPPORTING DOCUMENT	1. Total Pages 203

2. Title	3. Number	4. Rev No.
222-S Laboratory Interim Safety Basis (Laboratory R 5/3/94)	WHC-SD-CP-ISB-002	0

5. Key Words	6. Author
Interim Safety Basis (ISB), 222-S, Laboratory, Facilities	Name: Jay C. Lavender Signature Organization/Charge Code 8D120/YLF21

APPROVED FOR PUBLIC RELEASE

5/3/94 D. Dolis

7. Abstract

The purpose of this document is to establish the Interim Safety Basis (ISB) for the 222-S Laboratory. The ISB is a documented safety basis that provides a justification for the continued operation of the facility until an upgraded final safety analysis report (FSAR), which is planned to be completed in FY 99, is prepared. The ISB also provides the "authorization basis" for the unreviewed safety question (USQ) process defined in DOE Order 5480.21 and MRP 5.12.

9. Impact Level 2 ESQ

10. RELEASE STAMP

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DATE MAY 04 1994
Sta - 21

222-S LABORATORY INTERIM SAFETY BASIS

April 1994

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LIST OF TERMS

ALARA	as low as reasonably achievable
ANSI	American National Standards Institute
ARCHIE	Automated Resource for Chemical Hazard Incident Evaluation
ASME	American Society of Mechanical Engineers
CAM	continuous air monitors
CM	configuration management
DOE	U.S. Department of Energy
DOP	dioctyl phthalate
EDE	effective dose equivalent
EHSC	Environmental Hazard Safety Classification
EP	Engineering Practices
FRP	fiberglass-reinforced pipe
FSAR	final safety analysis report
HEDOP	Hanford Environmental Dose Overview Panel
HEPA	high-efficiency particulate air
HI&E	Hazard Identification and Evaluation
ICRP	International Commission on Radiological Protection
IDLH	immediately dangerous to life or health
ISB	Interim Safety Basis
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
PHA	preliminary hazards analysis
PNL	Pacific Northwest Laboratory
PUREX	Plutonium-Uranium Extraction Facility
TSR	technical safety requirement
UBC	Uniform Building Code
USQ	unreviewed safety question
VCP	vitrified clay pipe
WHC	Westinghouse Hanford Company

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1.0 EXECUTIVE SUMMARY

The purpose of this document is to establish the Interim Safety Basis (ISB) for the 222-S Laboratory. The ISB is a documented safety basis that provides a justification for the continued operation of the facility until an upgraded final safety analysis report (FSAR), which is planned to be completed in FY 99, is prepared. The ISB also provides the "authorization basis" for the unreviewed safety question (USQ) process defined in DOE Order 5480.21 and MRP 5.12.

The 222-S Laboratory ISB is based on the completion of the revised facility and process description and the revised accident analysis. However, when necessary existing facility specific documents have been used to provide additional information or basis.

The 222-S Laboratory has been categorized as a Category 3 Nuclear Facility, in accordance with DOE requirements, which implies that only the facility worker (i.e., not the onsite or offsite individual or environment) is at risk due to the operation of the 222-S Laboratory. Based on the results of the accident analysis, i.e., no unacceptable consequences to the onsite or offsite individual or the environment, there are no WHC safety class 1 or 2 systems or structures.

These conclusions are based on an initial condition, which is an assumed maximum bounding inventory. Therefore, a interim operational safety requirement, i.e., limiting condition for operation (LCO), and six subsequent administrative controls (AC) have been prepared to ensure that the 222-S Laboratory inventory does not exceed the maximum bounding inventory. Of the six ACs, three are mandated by DOE Order 5480.22, one of the ACs addresses the Inventory Control Program at the 222-S Laboratory, one AC addresses a violation of the LCO, and the sixth AC addresses configuration management (e.g., unreviewed safety questions and LCO derived mode changes). Protection of the facility worker will be assured via the implementation of existing WHC policy and 222-S Laboratory programs.

As a result of the revisions to the facility and process description and accident analysis, including safety equipment list and the interim operational safety requirements, it can be concluded that the safe operating envelope of the facility has been adequately evaluated. This document and the 222-S Laboratory operations documentation reviewed in support of this ISB, provide the "authorization basis" for the unreviewed safety question (USQ) process.

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2.0 INTRODUCTION

The following subsections summarize the 222-S Laboratory, as described in Chapter 3.0, and discuss the scope of the ISB evaluations.

2.1 DESCRIPTION OF THE 222-S LABORATORY

The 222-S Laboratory, located in the 200 West Area, has been classified as a low-hazard nuclear facility (Bourger 1993a). The 222-S Laboratory provides analytical chemical analysis for Westinghouse Hanford Company (WHC). The 222-S Laboratory consists of the 222-S Building and auxiliary buildings (see Figure 3-1). The 222-S Building is a two-story structure that is divided into laboratory support spaces (laboratories), office spaces, a multicurie wing (hot cells), and supplemental service areas (see Figure 3-3). The building is designed with its own waste handling and decontamination facilities, fire protection and alarm systems, ventilation system, and radiation monitoring system.

The auxiliary buildings are used for administrative offices, storing bulk materials, receiving samples, and transferring wastes to an onsite waste handling facility.

2.1.1 Hazard Categorization

Per U.S. Department of Energy (DOE) standard DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports* (DOE 1992), a facility is categorized based on its radiological inventory. That is, the sum of the ratios of each material quantity to the category threshold quantities does not exceed one, or

$$\sum_{i=1}^{j} \frac{\text{Inventory Quantity of Isotope}_i}{\text{Category Threshold Quantity of Isotope}_i} < 1.$$

The hazard categorization process is performed in two steps. First, the facility inventory by radionuclide is compared to the facility category threshold quantities. Second, the ratios are summed as described above.

The first step provides a preliminary indication as to whether or not the sum of the ratios will exceed one. That is, should any of the radionuclides identified in the facility inventory exceed the threshold quantities for a given facility category, the sum of the ratios will be greater than one. Therefore, this step also will identify which category threshold quantities should be used to determine the hazard categorization (or summation of the ratios). For example, if a radionuclide identified in the facility inventory exceeds the Category 3 facility threshold quantities, identified in DOE (1992), the Category 2 facility threshold quantities should be used to determine the facility hazard categorization.

The second step in the hazard categorization process is the summation of the ratios using the facility inventory and the threshold quantities for the facility category identified in the first step.

The radiological material inventory at the 222-S Facility is a continually fluctuating quantity given the nature of the work of a chemical analysis laboratory that supports all of the waste management operations of the Hanford Site. The initial hazard categorization for the 222-S Laboratory (Bourger 1993b) was based on a maximum inventory of 200 samples. However, the maximum inventory has been revised to 800 samples.

For the purpose of this hazard category determination analysis, the radiological inventory (Table 2-1) is based on a maximum inventory of 800 samples (625 g per one core equivalent sample or 100 analytical samples) in process or stored in the facility at any time and a maximum of approximately 177 g ^{239}Pu and/or ^{239}Pu equivalence (or approximately 11 Ci). The plutonium inventory is based on the "isolated facility" designation limiting the facility to 1/3 of critical mass rather than on sample analysis.

Table 2-1. 222-S Laboratory Radiological Inventory*.

Radionuclide	Curies/ 1 Sample	Curies/ 800 Samples
^{3}H	5.09 E-03	4.08 E+00
^{14}C	1.61 E-04	1.29 E-01
^{60}Co	1.08 E-02	8.65 E+00
^{90}Sr	6.24 E-01	4.99 E+02
^{99}Tc	1.32 E-03	1.06 E+00
^{129}I	1.17 E-03	9.33 E-01
^{137}Cs	1.58 E+00	1.27 E+03
^{147}Pm	1.90 E-01	1.52 E+02
^{238}Pu	5.44 E-04	4.35 E-01
^{239}Pu	4.63 E-03	1.10 E+01
^{241}Am	3.01 E-03	2.41 E+00
^{234}U	4.88 E-04	3.90 E-01
^{235}U	1.43 E-05	1.14 E-02
^{238}U	3.32 E-05	2.66 E-02
TOTAL	1.34 E+01	1.95 E+03

*Inventory taken from Bourger 1993b.

The facility hazard category was calculated (Table 2-2) using the radiological inventory identified in Table 2-1.

As discussed previously, the first step in the hazard categorization process is to ensure that total curies for each radionuclide do not exceed the threshold curie values, shown in Table 2-2, for a Category 3 or Category 2 facility. The Category 3 threshold quantities shown in Table 2-2 represent the maximum allowable per radionuclide for a radiological facility (as defined in DOE 1992). Similarly, the Category 2 threshold quantities shown in Table 2-2 represent the maximum allowable per radionuclide for a Category 3

Table 2-2. Hazard Category Calculation.

Radionuclide	Category 3 Threshold Curies	Category 2 Threshold Curies	Ratio of Facility Inventory to Category 2 Criteria
^{3}H	1.0 E+03	3.0 E+05	1.4 E-05
^{14}C	4.2 E+02	1.4 E+06	9.2 E-08
^{60}Co	2.8 E+02	1.9 E+05	4.6 E-05
^{90}Sr	1.6 E+01	2.2 E+04	2.3 E-02
^{99}Tc	1.7 E+03	3.8 E+06	2.8 E-07
^{129}I*	--	4.3 E+05	2.2 E-06
^{137}Cs	6.0 E+01	8.9 E+04	1.4 E-02
^{147}Pm	1.0 E+03	8.4 E+05	1.8 E-04
^{238}Pu	6.2 E-01	6.2 E+01	7.0 E-03
^{239}Pu	5.2 E-01	5.6 E+01	2.0 E-01
^{241}Am	5.2 E-01	5.5 E+01	4.4 E-02
^{234}U	4.2 E+00	2.2 E+02	1.8 E-03
^{235}U	4.2 E+00	2.4 E+02	4.8 E-05
^{238}U	4.2 E+00	2.4 E+02	1.1 E-04
	Sum of the ratios		2.9 E-01

*Specific category threshold values were not given for ^{129}I, therefore, as recommended (DOE 1992), the value of 4.3 E+05 Ci was used in the determination of this categorization.

nuclear facility. The results of the first-step comparative evaluation determine what category the facility is not and identify the facility category threshold quantities that will be used to determine the facility hazard categorization.

For example, the total curies of ^{239}Pu (11 Ci) exceed the Category 3 threshold curie (or maximum allowable for a radiological facility) criteria shown in Table 2-2. This is also true for ^{137}Cs and ^{90}Sr. Therefore, the facility cannot be categorized as a radiological facility. A similar comparison of the total curies for each radionuclide to the Category 2 threshold quantities (or maximum allowable for a Category 3 facility) indicates that none of the radionuclides exceed the Category 2 threshold quantities. Therefore, the Category 2 threshold values are used to determine the facility hazard categorization.

The second step, as discussed previously, requires that the sum of the ratios of the total quantity of each radionuclide to the category threshold quantities does not exceed one. Therefore, the total quantity of each radionuclide was divided by the threshold quantities for a Category 2 facility (see Table 2-2). These ratios were then summed to determine if the sum of the ratios exceeds one. As can be seen in Table 2-2 the sum of the ratios, or 0.22, does not exceed 1; therefore, the facility is classified as a Category 3 nuclear facility based on the maximum inventory shown in Table 2-1.

2.1.2 Worst Case Toxicological Release

As discussed in DOE 1992, Section 3.2, *Occupational and Nonradiological Hazards*, the safety basis should reference all hazardous chemical analyses and summarize any significant findings. This discussion requires the safety basis to meet the requirements of 29 CFR 1910.119, *Process Safety Management*, should the results of the analysis indicate that there is the potential for significant offsite consequences, or the quantity of any hazardous material exceeding the threshold quantities (TQ) identified in 29 CFR 1910, Appendix A. Therefore, the worst case toxicological release analysis contained in the facility hazard classification (Bourger 1993a) is summarized in the following paragraphs.

This analysis included an assessment of a postulated worst case scenario, i.e., an unmitigated release of 3,217 L (850 gal) of nitric acid. Although the chemicals contained in the 222-S Laboratory are used in qualitative and quantitative chemical analyses, those chemicals and gases are of kind and quantity found in typical industrial and commercial analytical chemical laboratories or chemical distribution warehouses. A screening evaluation of the chemicals determined that the worst case release of any chemical used in the 222-S Laboratory would be from bulk storage, based on several factors, e.g., onsite receptor location, dispersability of the chemical, storage location, etc. As such, release of nitric acid from a bulk storage tank located outside of the facility is considered the most credible and the most likely chemical release scenario.

Toxicological exposures were performed for the release of 850 gal (maximum tank capacity) of 70% nitric acid into an evaporating pool. The chemical source term was analyzed using the Automated Resource for Chemical Hazard Incident Evaluation (ARCHIE) computer code for estimation of vapor evolution rates. The rates were then multiplied by specific X/Q values (from the radiological analysis) for the onsite and offsite receptors. The results are summarized in Table 2-3.

Table 2-3. Summary of Toxicological Results and Comparison to Criteria.

Receptor	Calculated exposure (ppm)	Risk acceptance guideline value* (ppm)
Onsite (900 m, NW)	2.3	≤ 15 ppm (ERPG-2)
Offsite (13.5 km, W)	0.13	≤ 2 ppm (ERPG-1)

*Taken from WHC-CM-4-46.
ERPG = Emergency Response Planning Guide.

This analysis, based on the consequences shown in Table 2-3, demonstrates that for a worst case scenario the consequences are insignificant and that the requirements of 29 CFR 1910.119 do not apply. In addition, none of the hazardous materials exceed the TQs shown in 29 CFR 1910, Appendix A.

2.2 INTERIM SAFETY BASIS SCOPE

The 222-S Laboratory ISB demonstrates that the facility can be operated safely, based on the safety analyses (Chapter 4.0) and other supporting documents (e.g., "222-S Laboratory Facilities Hazards Identification and Evaluation" (HI&E), etc.). The ISB results will support continued operation of the facility until the existing safety documentation can be upgraded to meet the requirements of DOE Order 5480.22, *Technical Safety Requirements*, and DOE Order 5480.23, *Nuclear Safety Analysis Reports*. The activities listed in Table 2-4 have been performed in support of the ISB.

The ISB provides adequate documentation to support the operation of the 222-S Laboratory, including a revised hazard classification, accident analysis, and safety equipment list. This ISB also documents the evaluation of the 222-S Laboratory as modified by Projects W-001, ventilation system upgrades and W-041, hot cell addition. This defines the authorization basis for performing unreviewed safety question (USQ) screenings and evaluations in accordance with WHC procedures and DOE Order 5480.21, *Unreviewed Safety Questions*.

Table 2-4. Interim Safety Basis Activities.

Activity	Action
1	<u>Hazard Classification Evaluation</u>--The hazard classification analysis (Bourger 1993a) was reviewed and reanalyzed in accordance with DOE Standard 1027 (DOE 1992).
2	<u>Operations and Facility Description</u>--The operations and facility description referenced in the HI&E have been revised to reflect the current configuration.
3	<u>Accident Analysis</u>--The accident analysis, currently contained in the HI&E, has been revised. This revision is needed to evaluate the current facility configuration to provide a safety basis for the identification of safety class systems/structures.
4	<u>Safety Equipment List</u>--A revised safety equipment list (see Chapter 5.0) has been prepared based on the revised accident analysis.

DOE = U.S. Department of Energy.
HI&E = Hazard Identification and evaluation.
TSR = technical safety requirement.

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3.0 DESIGN OF PRINCIPAL STRUCTURES, COMPONENTS, SYSTEMS, ENGINEERED SAFETY FEATURES, AND PROCESSES

This chapter describes the general design of principal structures, components, and engineered safety systems provided to fulfill the mission of the 222-S Laboratory which are located in the 200 West Area (Figure 3-1). A description of operations presents an overview of the equipment, personnel, and general flow of material through the facility.

The current mission of the 222-S Laboratory is to provide quality analytical chemistry services in support of the Hanford Site processing plants with emphasis on waste management, chemical processing, and environmental monitoring programs at B Plant, UO_3, Tank Farms, 242-A and 242-S Evaporators, Waste Encapsulation Storage Facility, Plutonium-Uranium Extraction (PUREX) Facility, Plutonium Finishing Plant, process development/upset activities, and essential materials.

3.1 FACILITY DESCRIPTION

At present there are 21 buildings, structures, and other facilities comprising the 222-S Laboratory (see dashed box on Figure 3-2). Of this number, eight are administrative and office buildings, and the remainder are directly involved in laboratory, laboratory support, or waste handling activities in support of the current mission of the 222-S Laboratory. The following sections briefly describe each of the facilities.

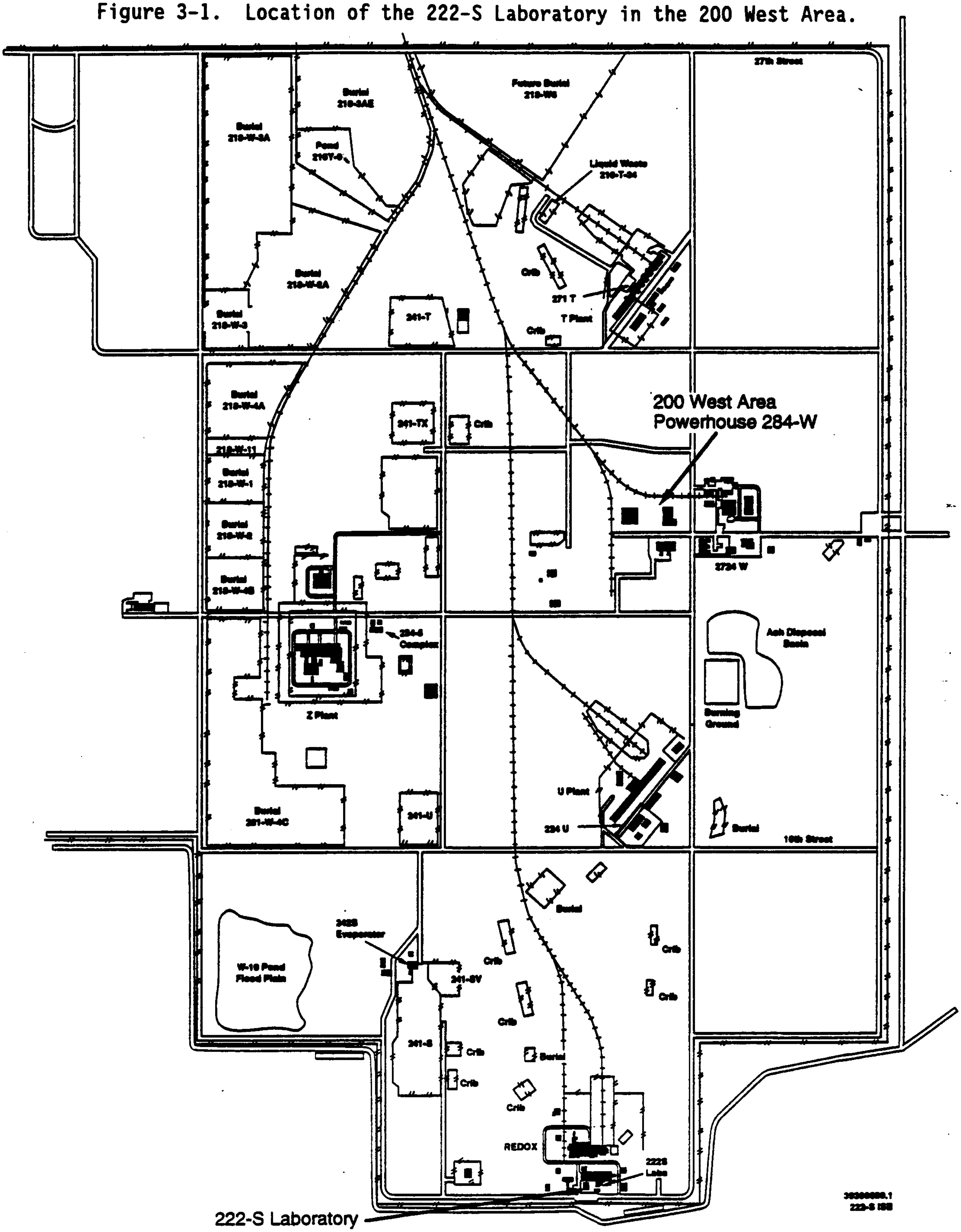
3.1.1 Laboratory and Support Facilities

The laboratory and support facilities consist of the 222-S Building, which provides analytical chemical analysis services for WHC, and the auxiliary buildings which support the mission of 222-S Laboratory. Each of the laboratory and support facilities is described individually in the following paragraphs.

<u>222-S Building</u>--The 222-S Building is a two-story building 98.1 m (322 ft) long and 32.6 m (107 ft) wide located in the southeast corner of the 200 West Area (Figure 3-2).

The first floor of the 222-S Building (Figure 3-3, sheet 1 of 4) is divided into four general areas. The west end contains the lunchroom, offices, and locker rooms, which are maintained free of radioactivity and toxic chemicals. The west central section contains laboratories and service areas for work with low- to intermediate-level radioactive and/or toxic materials. The east central section, commonly referred to as the multicurie section, contains laboratories, hot cells, and service areas for working with intermediate- to high-level radioactive samples. The east and west central sections contain laboratory benches and hoods that are normally supplied with services such as electrical outlets and process vacuum. The east end contains the Hot Cell Facility (Room 11A). The Hot Cell Facility contains six cells for instrument analysis of high-level samples. The partial basement contains

Figure 3-1. Location of the 222-S Laboratory in the 200 West Area.



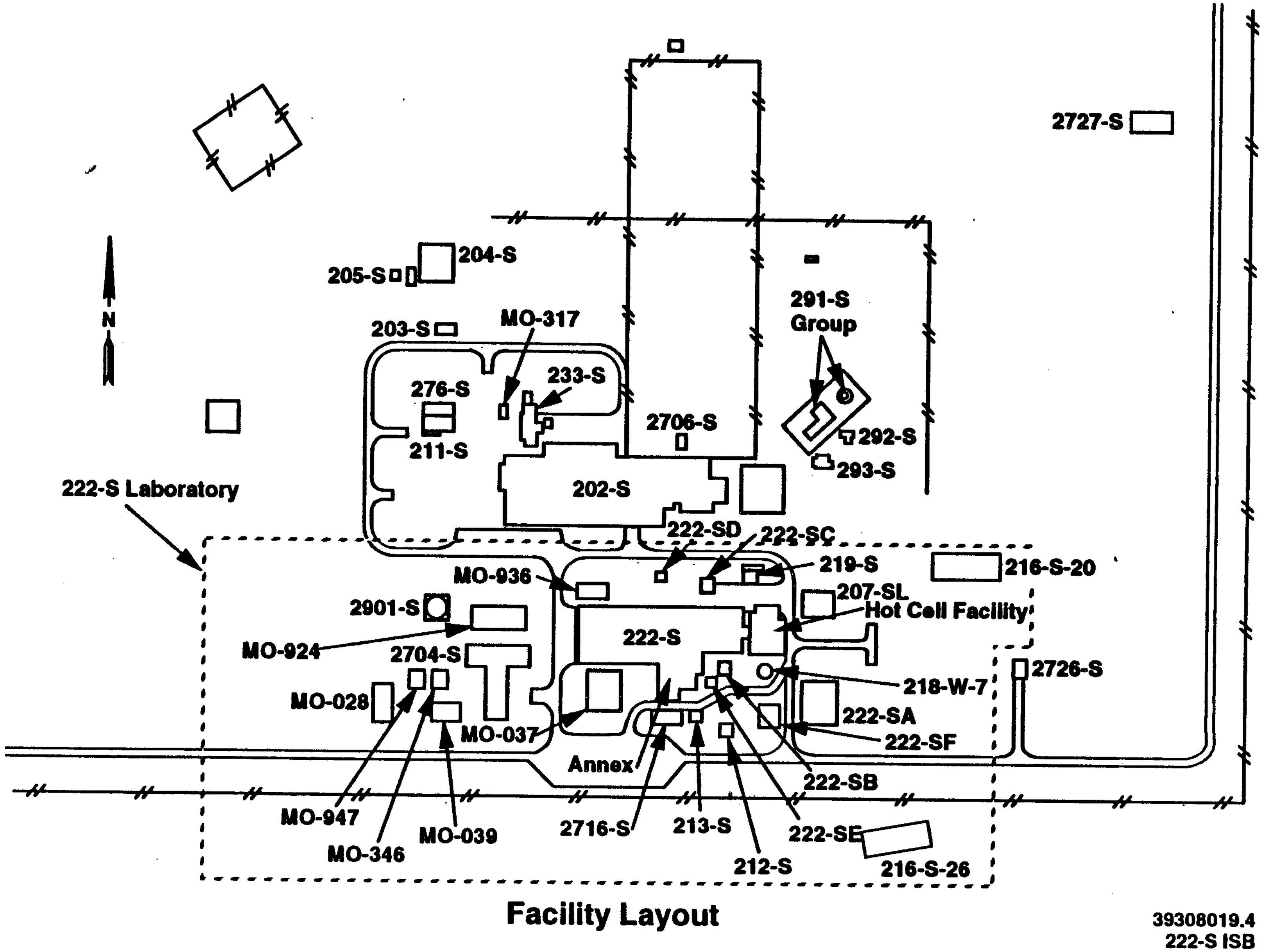
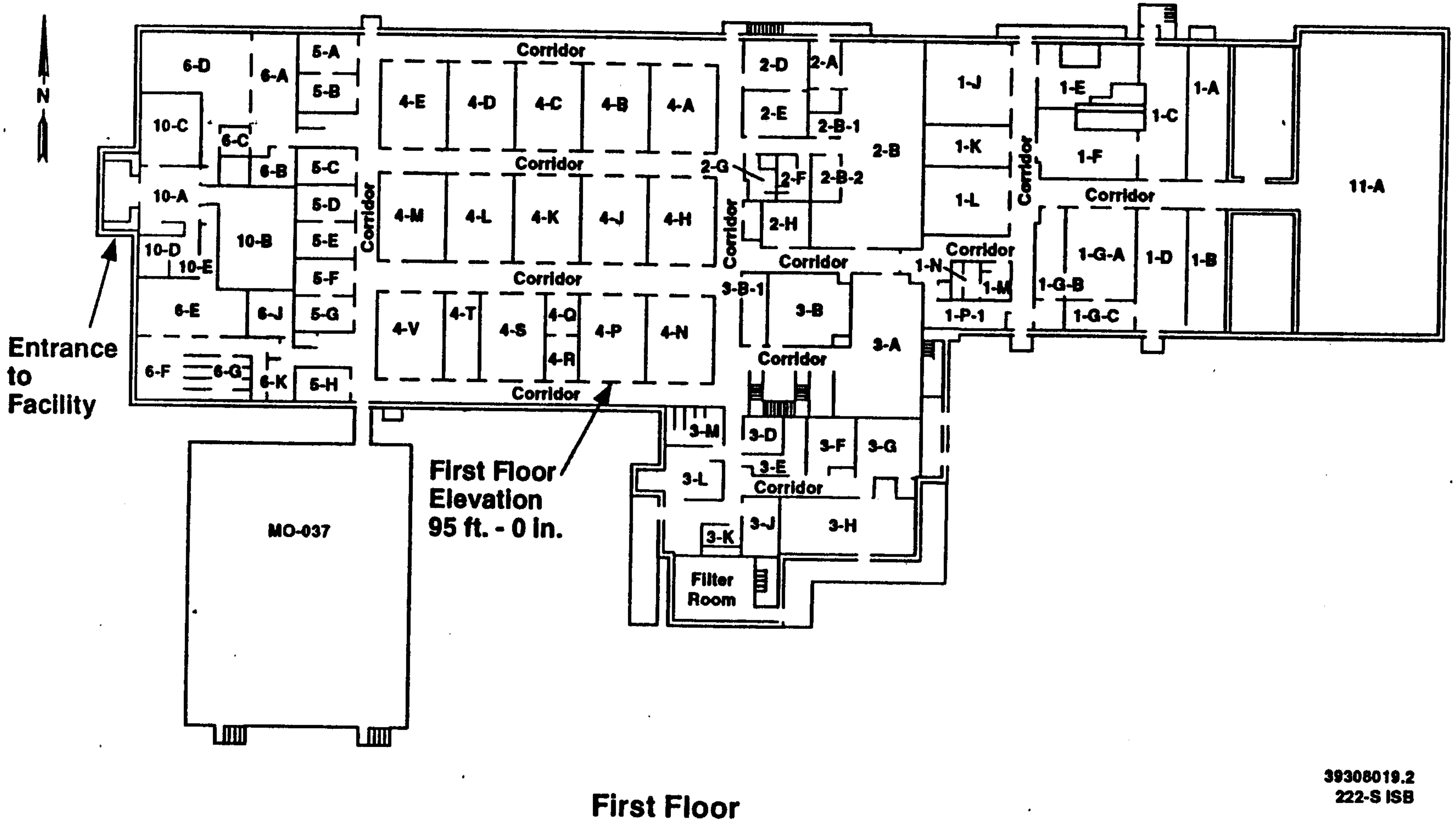


Figure 3-2. 222-S Laboratory.



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222-S ISB

Figure 3-3. 222-S Building Layout. (sheet 1 of 4)

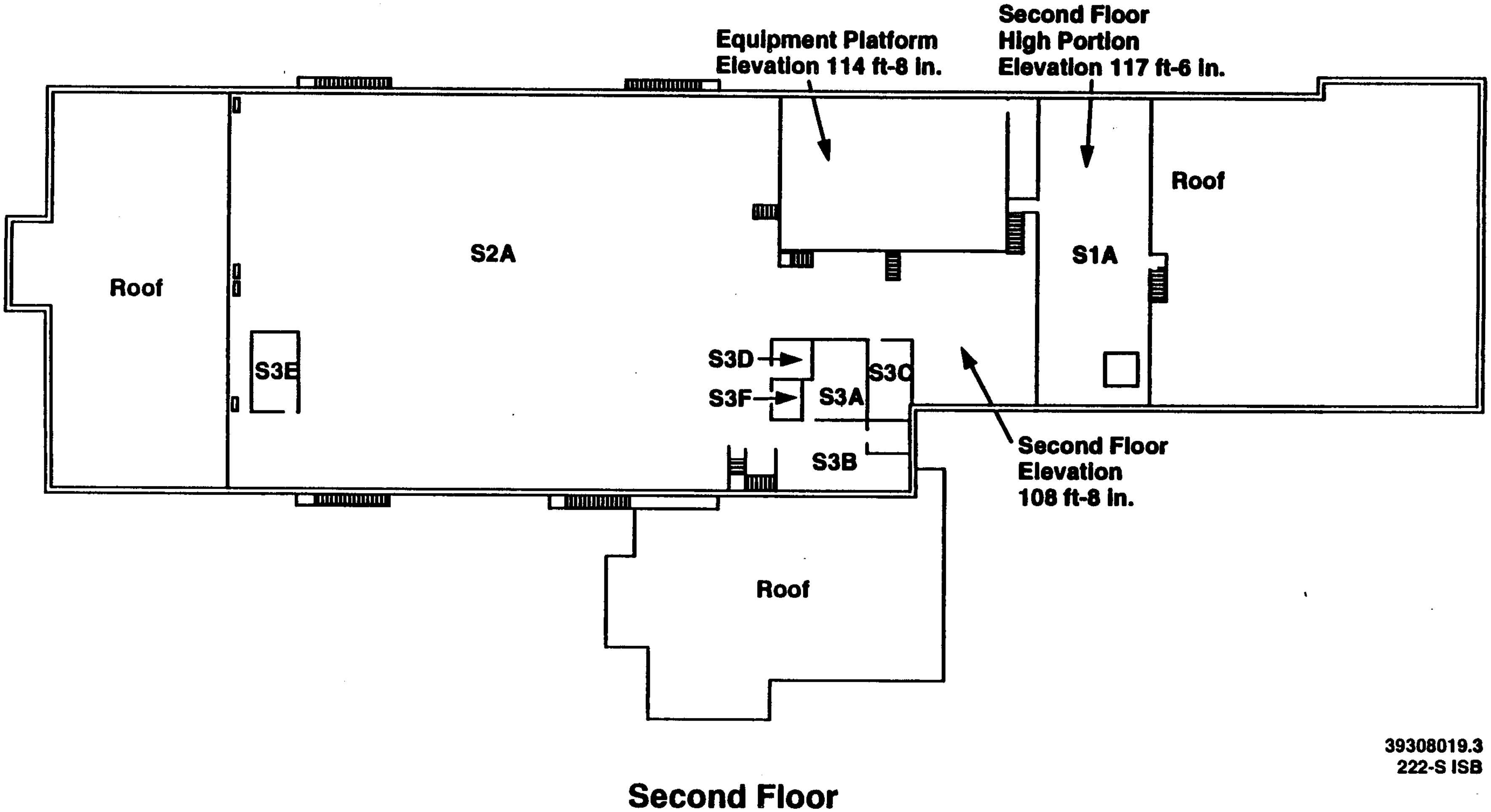
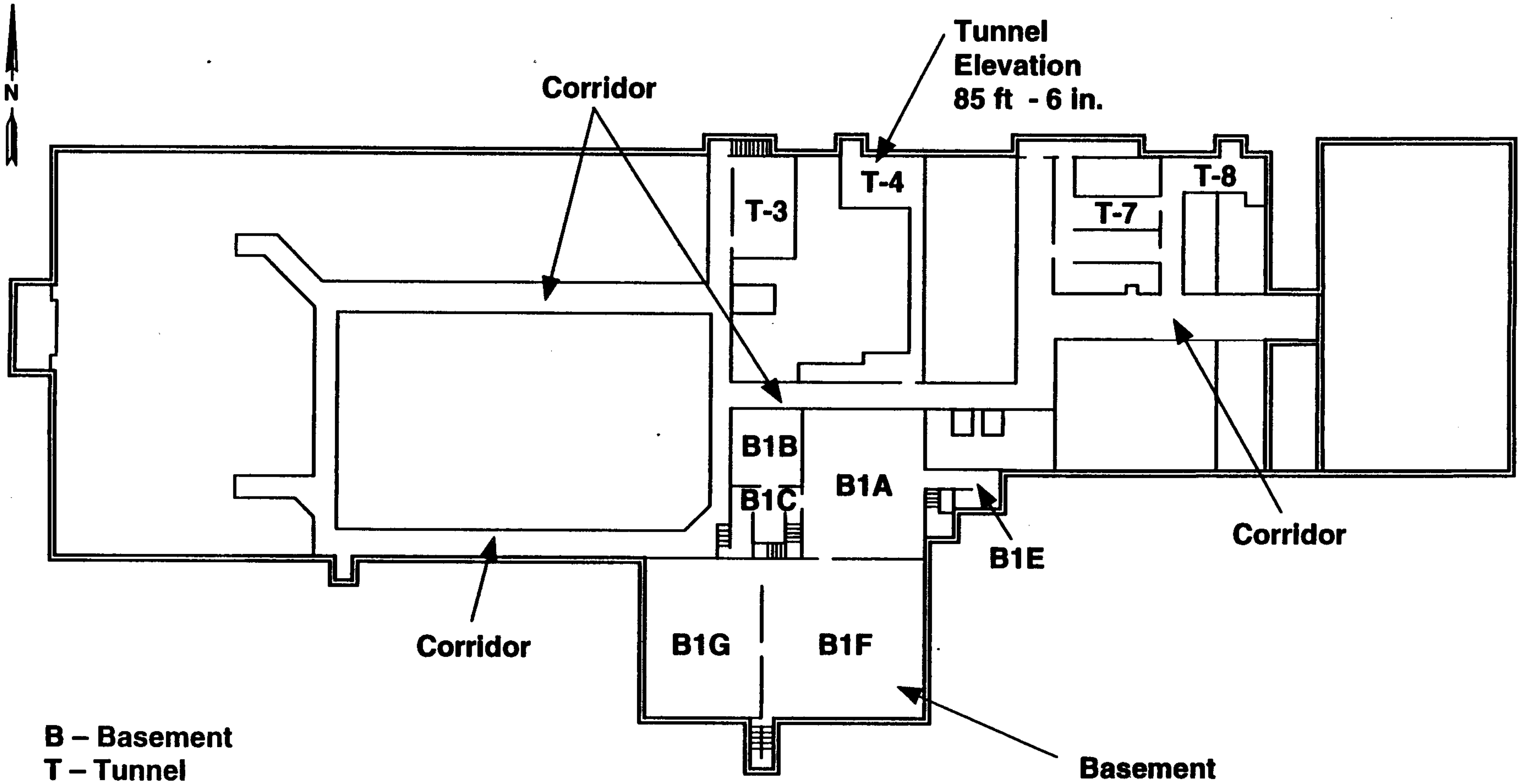


Figure 3-3. 222-S Building Layout. (sheet 2 of 4)



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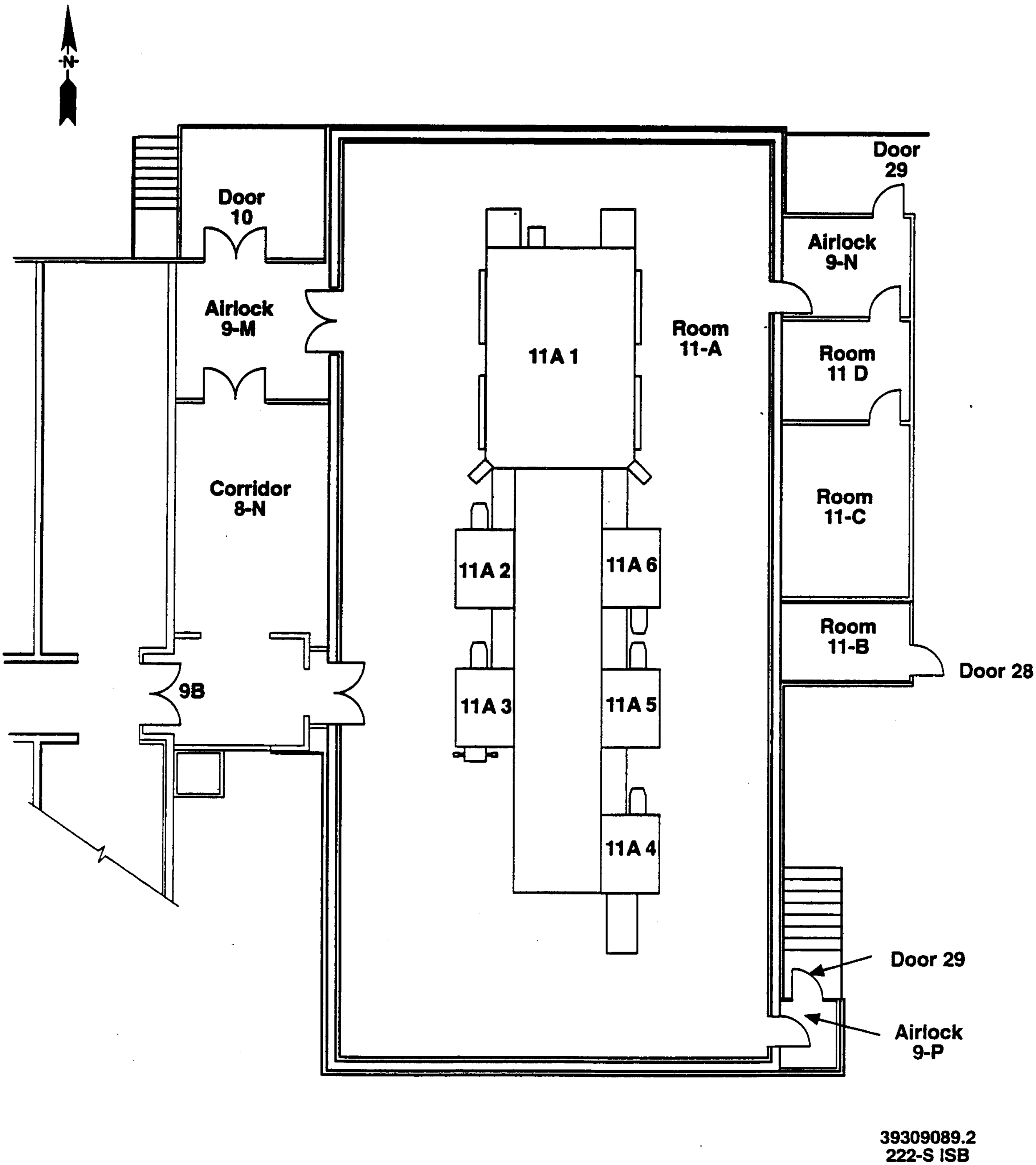
222-S ISB

Figure 3-3. 222-S Building Layout. (sheet 3 of 4)

Figure 3-3. 222-S Building Layout. (sheet 4 of 4)



service piping, vacuum pumps, a counting room, an instrument maintenance shop, and a scanning electron microscope laboratory. The second floor contains the ventilation supply fans, supply and exhaust ductwork, the ventilation system control room, a glass shop, and storage areas. This area is maintained free of radioactive contamination.

<u>222-S Building Annex</u>--The 222-S Building Annex, which is attached to the south side of the 222-S Building (Figures 3-2 and 3-3, sheet 1 of 4), houses the maintenance shop, instrument shop, and the counting room filter building.

<u>222-SA Standards Laboratory</u>--The 222-SA Laboratory (Figure 3-2) is a five-wide trailer located southeast of the 222-S Building. Nonradioactive standards for the PUREX Analytical Laboratory, 234-5 Analytical Laboratory, and 222-S Analytical Laboratory are prepared in part of this laboratory. Nonradiological process development work is done in the other section of the laboratory.

<u>222-SB Filter Building</u>--The 222-SB Filter Building, located south of the 222-S Building (Figure 3-2), houses 96 high-efficiency particulate air (HEPA) filters to provide final filtration for the 222-S Laboratory. Under normal operation of the ventilation system, two 29,000-ft^3/min electrically powered fans exhaust air from the 222-S Laboratory. Exhaust air leaves the 222-S Filter Building through the 296-S-21 stack. A third electrically powered fan provides backup capability if one of the other two fans fails. If two or more of the electrically powered exhaust fans fail to operate, emergency exhaust ventilation will be provided by the 222-SE Filter Building. All HEPA filters in laboratory hoods, gloveboxes, hot cells, auxiliary laboratory outlets, and stack discharges are tested annually with dioctyl phthalate (DOP), or equivalent, to assess filter efficiency. Filters that fail to meet performance standards are replaced.

<u>222-SC Filter Building</u>--The 222-SC Filter Building, located north of the 222-S Building (Figure 3-2), contains the second- and third-stage HEPA filtration for hot cells 1-A, 1-E-1, 1-E-2, 1-F, and 11-A-1 through 11-A-6. The hot cells in rooms 1-A, 1-E, 1-F, and 11-A are serviced by the main building supply and exhaust ventilation, but additional features are present to increase safety and containment. The 222-SC Filter Building houses five parallel pairs of HEPA filters, which provide filtration to hot cell exhaust air before it enters the main exhaust plenum and final filtering in the 222-SB Filter Building. A total of four stages of HEPA filtration are provided for the hot cell ventilation exhaust.

<u>222-SE Filter Building</u>--The 222-SE Filter Building, located south of the 222-S Building (Figure 3-2), is a new facility that houses 56 HEPA filters. This building provides redundant backup filtering capabilities for the 222-S Laboratory exhaust. The diesel exhaust fan for this building provides ventilation in case of loss of electricity or during maintenance activities on the 222-SB Filter Building.

<u>222-SF Material Staging Area</u>--222-SF is located southeast of the 222-S Building (Figure 3-2). This area is designed as a material staging area where new laboratory equipment is stored, or staged, before its installation in one of the laboratory or support facilities.

2716-S Storage Building--The 2716-S Storage Building, located south of the 222-S Building (Figure 3-2), is a 158-m^2 (1,700-ft^2) metal building with 18.6 m^2 (200 ft^2) partitioned off for the storage of acids, bases, and other chemicals. It provides both long- and short-term storage capability for laboratory materials and contains no radioactive materials.

3.1.2 Waste Handling Facilities

Those facilities dedicated to the processing, storage, or handling of wastes generated within the 222-S Laboratory and auxiliary buildings are described in the following paragraphs.

207-SL Retention Basin--The 207-SL retention basin, located northeast of the 222-S Building (Figure 3-1), acts as a temporary holding facility for potentially radioactive or hazardous liquid effluents before their discharge to the 216-S-26 crib. Waste water from the laboratory, normally free of radioactive and hazardous chemical contamination, is routed to the 207-SL retention basin. This facility is comprised of two below-grade 94,635-L (25,000-gal) compartments and three above-grade 75,708 L (20,000 gal) tanks. This facility allows batch collection, sampling, and discharge of the waste. If the waste water meets alpha, beta, gamma, and pH specifications for surface discharge (WHC-CM-7-5), it is routed to the 216-S-26 crib, located southeast of the 222-S Building outside the 200 West Area exclusion area. Water not meeting radioactive specifications or pH and/or hazardous waste requirements is handled as specified in the *Facility Effluent Monitoring Plan for the 222-S Laboratory*, (FEMP) (Nickels and Warwick 1992).

216-S-26 Crib--The 216-S-26 crib, located southeast of the 222-S Laboratory and outside the 200 West Area fence (Figure 3-2), receives all chemical sewer effluents that are collected in the 207-SL retention basin. The crib was designed to handle laboratory waste water at 283,905 L/d (75,000 gal/d) or 94,635 L/8-h shift (25,000 gal/8-h shift). Operation and control of this crib are the responsibilities of Tank Farm Operations.

218-W-7 Dry Waste Burial Ground--The 218-W-7 Dry Waste Burial Ground is located south of the 222-S Building (Figure 3-2). Although, this underground tank was removed from service some time before 1975, it has not been removed and currently contains waste. It was used primarily for disposal of contaminated dry hood waste generated by the 222-S Laboratory.

219-S Waste Handling Facility--The 219-S Waste Handling Facility, located north of the Hot Cell Addition to the 222-S Building (Figure 3-2), collects radioactive contaminated liquid waste generated by the 222-S Laboratory operations. This facility consists of an 8.2-m by 7.6-m (27-ft by 25-ft) below-grade containment vault, a 6.7-m by 4.0-m (22-ft by 13-ft) operations building, and an attached 4.0-m by 2.5-m (13-ft by 8-ft) concrete-walled sample gallery. The containment vault is divided into two sections, called cells A and B, which contain the three liquid waste tanks and a moisture deentrainer tank. The waste tanks are vented through the deentrainer and a HEPA filter to the atmosphere via the 296-S-16 stack. The operations building contains the operating gallery, the pipe trench, and a 2,650-L (700-gal) tank of caustic that is used to neutralize the waste tanks. The concrete sample gallery contains the waste sampling hood, which is vented through HEPA filtration to the atmosphere via the 296-S-23 stack.

222-SD Solid Waste Handling/Storage System--The 222-SD Solid Waste Handling/Storage System, located north of the 222-S Building (Figure 3-2), is a concrete-shielded drum storage area that was constructed under Project B-161. This area is used for temporary storage of radioactive waste drums before transfer to the burial ground. It is equipped with an electrically driven jib crane for remotely positioning the drums in the storage area and for remotely loading the drums on the bed of the waste truck.

3.1.3 Administrative and Office Buildings

There are eight administrative and office buildings (Figure 3-2) located within the 222-S Laboratory. One of these buildings is a permanent structure (2704-S Building), and the others are trailers (or modular offices [MO]). All of these buildings are used primarily as office buildings for the administrative support of the laboratory facilities. One of the facilities (MO-037) contains the Laboratory Standards Control Computer, which is used directly in laboratory operations. The administrative and office buildings (Figure 3-2) are identified in the following paragraphs.

3.2 STRUCTURES

The 222-S Laboratory was originally constructed between 1950 and 1951 to the building codes and standards applicable at the time. Since 1951 the building has been modified to increase the original laboratory and office space. The modifications were designed and constructed to the applicable codes and standards current at the time the modifications were performed.

The original 222-S Laboratory was designed to meet the codes and standards in place in 1949 (Turnbull 1949). The applicable portions of the following codes were used during facility design and construction efforts: *Uniform Building Code* (UBC 1949); and all codes recommended by the National Board of Fire Underwriters. Applicable standards from the following organizations also were used: American Society for Testing and Materials; American Institute of Steel Construction; American Welding Society; American Institute of Electrical Engineers; National Electrical Manufacturers' Association; and National Association of Fan Manufacturers. Other design and construction specifications were taken from the applicable Washington State codes, federal specifications, and Hanford works specifications.

During 1974, the functional design criteria for exhaust ventilation improvements to the 222-S Building were developed and approved (Vitro 1974). In compliance with these criteria, the 222-SB Filter Building and connecting ductwork were constructed. Applicable standards and specifications from the following sources were used in the design and construction efforts: American Association of State Highway Officials; American Conference of Government Industrial Hygienists; American Concrete Institute; American Institute of Steel Construction; Air Moving and Conditioning Association; American National Standards Institute (ANSI); American Society of Mechanical Engineers; American

Society for Testing and Materials; American Welding Society; National Electrical Manufacturers' Association; National Fire Protection Association (NFPA); Sheet Metal and Air Conditioning Contractors National Association; Steel Structures Painting Council; and Underwriters' Laboratories. Other applicable specifications and criteria which were complied with included federal specifications, OSHA regulations, and Hanford Plant Standards.

During 1980 two buildings were added to the 222-S Laboratory, the 222-SC Filter Building and the 222-S Annex. Both buildings were designed to the 1979 UBC (UBC 1979), the NEC, and other applicable codes and standards (RHO 1979 and 1980).

In September 1980 the 222-SA Standards Laboratory was procured. This facility is a five-wide trailer which was installed on a concrete foundation. The units were purchased from a commercial manufacturer, and they were designed and manufactured to all applicable UBC, NEC, and other codes for general purpose modular facility construction (Vitro 1978).

Construction is currently underway on a new exhaust filter building (222-SE) and a hot cell expansion to the 222-S Building. The 222-SE Filter Building has been designed to the applicable requirements (KEH 1992) of DOE Order 6430.1A, *General Design Criteria*, and the UBC for 1991 (UBC 1991). The hot cell expansion has been designed to the requirements of Division 11, "Equipment," and Division 13, "Special Facilities" (Sections 1300, "General Requirements," and 1325, "Laboratory Facilities" [including hot laboratories]) of DOE Order 6430.1A and UBC 1991 (WHC 1991). Both the 222-SE Filter Building and hot cell expansion designs meet or exceed the following requirements:

- Seismic: Important or low-hazard facility, maximum ground acceleration of 0.12g, UCRL 15910 (Kennedy et al. 1989); Zone 2B, importance factor I = 1.25, UBC (1991)

- Wind: ANSI A58.1, Section 6 (ANSI 1982); UCRL 15910, basic wind speed of 112.6 km/h (70 mi/h), importance factor I = 1.07 (for 100-year recurrence level), Exposure Category C (Kennedy et al. 1989)

- Roof Loads: ANSI A58.1, Section 4 (ANSI 1982); snow loads of 97.6 kPa (20 lb/ft^2) in accordance with ANSI A58.1, Section 7.

DOE Order 6430.1A imposes the requirements of UCRL 15910, which defines design and evaluation criteria for protection against natural phenomena hazards (i.e, seismic, extreme wind, and flooding). The goals of this guideline are to ensure that DOE facilities are constructed to withstand safely the effects of natural phenomena without excessive conservatism and to provide uniformity between DOE facilities. The principle of this guideline is to identify structures and equipment which, if damaged, would result in a safety hazard. The project seismic design is based on both UBC 1991 and UCRL 15910 requirements.

3.3 PROCESS SYSTEMS

3.3.1 General Laboratory Activities

Samples entering the laboratory are logged in by the laboratory leader. The health physics technicians survey incoming samples before they are transferred to the laboratory room where analysis will be performed. After sample analysis and final results are reported, the sample is transferred to TK-101 or TK-103 in the 219-S Waste Handling Facility.

Except for rooms in the northeast corner of the first floor (rooms 1-A, 1-C, 1-E, and 1-F) and room 11-A in the Hot Cell Facility (Figure 3-3, sheets 1 and 4 of 4), where highly radioactive materials (>100 mrem/h) are handled, the laboratory handles materials of low (<10 mrem/h) to intermediate (10 to 100 mrem/h) levels of radioactivity. In the individual laboratory rooms, these materials are processed within open-face or arm-ported hoods where high inlet-air velocities are maintained to prevent contamination of the laboratory room or personnel within the room.

Other than the radioassay of contained sources in the basement counting room, laboratory technical functions (e.g., analysis of samples) are performed in the first-floor laboratory rooms. The size, shape, equipment layout, and work assignments vary from room to room. However, some general observations can be made that characterize these rooms and the work that is performed in them.

The laboratory work, such as wet chemical analyses, is performed in fume hoods. The laboratory rooms have several hoods arranged in rows along the laboratory walls. Ventilation exhaust air flows from the corridors and rooms through the hoods and into the ventilation exhaust air system. The face velocity is high enough to prevent the flow of airborne radioactivity or noxious fumes from the hoods into the laboratory rooms. Many hoods are dedicated to specific activities that are posted on the outside wall of the hoods. Most of the hoods are provided with vacuum and electricity. One or more of the following gases may be available (piped) to the hoods: propane, methane, hydrogen, nitrous oxide, argon, nitrogen, and oxygen. Many of these laboratory rooms have center-island work benches that are provided with water sinks, drains, and storage cupboards. These benches are used for less hazardous work such as weighing reagents and cleaning glassware. The laboratories are equipped, as needed, with standard laboratory equipment such as glassware, balances, reagents in small-quantity containers, clamps, and stands. Lead bricks are normally provided in the laboratories so small lead-shielded enclosures can be constructed for temporary storage of small quantities of radioactive materials.

Normally, highly radioactive material, such as many of the fission product process control samples, are diluted to low dose rate levels before laboratory processing. These dilution operations are performed either in the hot cells or in a special shielded hood that is equipped with lead shielding. The hot cells are usually used to handle the more highly radioactive material and the larger, more cumbersome, radioactive material containers. Occasionally, microliter amounts of high activity samples are analyzed outside the hot cell for pH.

3.3.2 Operational Environmental Monitoring

Operational environmental monitoring requirements and procedures for areas near the 222-S Laboratory are contained in WHC-CM-7-5, *Environmental Compliance Manual*, and WHC-CM-7-4, *Operational Environmental Monitoring*. This program provides site-specific environmental monitoring for facilities managed by WHC. This site-specific monitoring protects personnel and facilities managed by WHC and ensures compliance with WHC requirements and local, state, and federal regulations.

The general requirements for environmental monitoring programs at DOE sites are contained in the following DOE orders and regulatory guides:

- DOE/EH-0173T, *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (DOE 1991)
- DOE Order 5400.1, *General Environmental Protection Program*
- DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, Chapter I, Section 8, and Chapter II, Section 6.

3.3.3 Conduct of Operations

The conduct of operations program for the 222-S Laboratory is addressed in WHC-SD-CP-HSP-001, *Westinghouse Hanford Company Chemical Hygiene Program* (WHC 1992) and WHC-CM-5-4, *Laboratories Administration*. An assessment of the conduct of operations of the 222-S Laboratory is provided in Appendix A. This assessment evaluates the facility-specific documentation to the WHC programs, ensuring that the facility has established programs and/or operations addressing the following institutional controls and safety requirements:

- Radiation protection
- ALARA
- Occupational safety
- Fire protection
- Industrial safety
- Industrial hygiene
- Criticality safety
- Training for nuclear facilities
- Radioactive waste management
- Occurrence reporting
- Quality assurance
- Configuration management (see Section 3.2.3)
- Conduct of operations
- Emergency planning
- Environmental protection.

3.3.4 Configuration Management

Configuration management (CM), as defined in draft DOE Order 5480.CM, *Configuration Management Program*, is an integrated management program encompassing design control, document control, and change control. The purpose of the CM program is to ensure that facility physical configuration conforms with the reviewed and approved design requirements and the facility and design requirements are accurately reflected in the facility documentation.

The 222-S Laboratory ISB will be reviewed annually to ensure that the authorization basis is valid. This will include reviewing the facility and process descriptions and accident analysis. If necessary, these descriptions will be modified via the engineering change procedure specified in WHC-CM-1-3, *Management Requirements and Procedures*. This annual review of the facility safety analysis documentation is required by WHC-CM-4-46, *Nonreactor Facility Safety Analysis Manual*.

Changes in the design/configuration of the facility are addressed in WHC-CM-6-1, *Standard Engineering Practices*. This manual establishes the Engineering Practices (EPs), which ensure that uniform methods are in place for all WHC engineering tasks. These practices provide uniform methods for such tasks as design review, configuration control, change control, engineering documentation preparation, and review/approval requirements. In addition, all facility modifications will be evaluated, using the ISB as the authorization basis, in accordance with WHC-CM-1-3, MRP 5.12, "Identifying and Resolving Unreviewed Safety Questions."

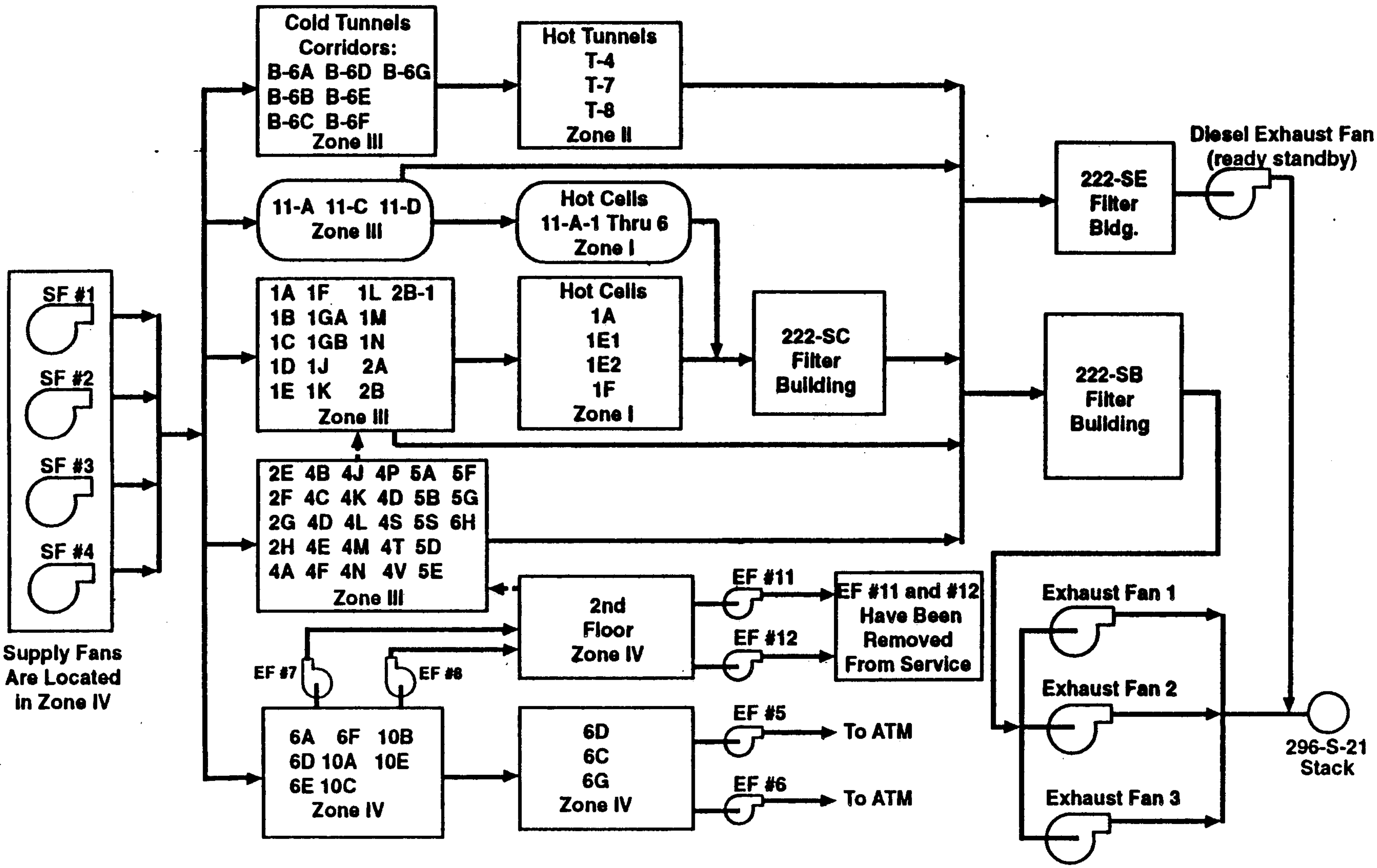
It can be concluded that an adequate CM program has been implemented at the 222-S Laboratory. This conclusion is based on the commitment to perform annual reviews and update of this ISB in accordance with WHC-CM-4-46. It is also based on the facility's commitment to implement an USQ Program, in accordance with WHC-CM-1-3, MRP 5.12, and the facility's commitment to implement WHC-CM-6-1.

3.4 UTILITIES AND SUPPORT SYSTEMS

3.4.1 Heating and Ventilation

The ventilation air supply system provides ≈2,120 m^3/min (≈75,000 ft^3/min) to the 222-S Building (Figure 3-4). The supply system takes in outside air on the second floor of the building (Figure 3-3, sheet 2 of 4). The air is filtered and brought to a constant temperature of 22.2 °C (72 °F). It is then discharged into a main supply plenum from which branch ducts distribute the air throughout the building. Four electrically driven supply fans are installed; three are in operation and the fourth is maintained inconstant standby service. The electrical distribution system provides a completely redundant electrical supply to the entire building, including the supply and exhaust fans.

The main supply ducts originate from the supply plenum and are equipped with steam-heated booster coils that are individually controlled by thermostats located in various sections of the building. The supply ducts are



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222-S ISB

Figure 3-4. 222-S Building Ventilation System.

arranged so that the major air supply enters the offices and corridors and an auxiliary supply enters the laboratory rooms through the perforated ceilings. The supply system is set up in this manner so that the airflow will be from the offices, through the corridors, and into the laboratories. That is, from "cold" areas to areas of potential radioactive contamination.

Pressure in the supply air plenum is maintained and controlled by a microprocessor control system. The control system senses pressure in the supply air plenum and varies the axial vanes on the supply fans to maintain the static pressure in the supply air plenum at 0.65 in. w.g. The low/high alarm set points for the supply plenum pressure are set at 0.6 in. w.g. and 0.75 in. w.g., respectively. A pressure switch interlocked to the exhaust plenum differential pressure is maintained between -6.0 in. w.g. and -6.7 in. w.g. The high/low alarm set points for the exhaust plenum pressure are set at -7.7 in. w.g. and -5.6 in. w.g., respectively. The microprocessor control system will start the diesel exhaust fan in the 222-SE Filter Building if the exhaust plenum pressure drops below -5.0 in. w.g. The diesel start switch is powered from the power buss and is designed to fail in the start mode on loss of electrical power.

Air from the lunchroom and locker room area in the west end of the building is exhausted through duststop type filters to the second floor to provide heating or cooling of this area. Exhaust air from offices in the west end of the building is exhausted via louvered doors to the first floor hallways. The major volume of exhaust air from the first floor is exhausted via the laboratory hoods or hot cells. The remainder leaves by room exhausters in specific locations. A velocity of 38.1 m/min (125 ft/min) is maintained through the face opening of the hoods. This is required for containment, and hoods are taken out of service if this requirement is not met. Laboratory hood and auxiliary exhaust air is filtered by a prefilter and single-stage HEPA filter before entering the exhaust ducts. Exhaust air from the basement service tunnels is filtered by a prefilter and single-stage HEPA filter. The individual exhausts are manifolded into a main exhaust duct that leads to the main exhaust plenum.

Building exhaust air is directed through a second stage of HEPA filtration before stack discharge. The 222-SB Filter Building, located south of the 222-S Building, houses 96 HEPA filters to provide final filtration. Under normal operation of the ventilation system, three 29,000-ft^3/min (rated capacity) electrically powered fans exhaust air from the laboratory. Exhaust air leaves the 222-S Building through the 296-S-21 stack. If two or more of the electrically powered exhaust fans fail to operate, emergency exhaust ventilation will be provided by the 222-SE Filter Building. All HEPA filters in laboratory hoods, gloveboxes, hot cells, auxiliary laboratory outlets, and stack discharges are tested annually with DOP, or equivalent, to assess filter efficiency. Filters that fail to meet performance standards are replaced.

The 222-SE Filter Building, located south of the 222-S Building, is a new facility that houses 56 HEPA filters. This building provides redundant backup filtering capabilities for the building exhaust. The diesel exhaust fan for this building provides one-half of the normal exhaust ventilation flow rate in case of loss of electricity or during maintenance activities on the 222-SB Filter Building.

Hot Cell Ventilation--Hot cells are cubicles generally built of steel and high-density concrete capable of reducing radiation dose rates from thousands of rems per hour in the cubicle to <10 mrem/h through the outer wall. The hot cells are used for operations that exceed operating limits for the hoods. There are 10 hot cells in the 222-S Building: one each in rooms 1-A and 1-F; two in room 1-E; and six in room 11-A. The hot cells are equipped with manipulators and hoists for remote handling, leaded glass windows for observation, and transfer drawers and/or pass-throughs that provide for input and removal of sample equipment and waste. Liquid waste from the hot cells in rooms 1-A, 1-E, and 1-F is disposed of through drains in the cells to the 103 tank in 219-S. Liquid waste from the 11-A hot cells is disposed of through drains in the cells to tank 101 in 219-S.

The hot cells in rooms 1-A, 1-E, 1-F, and 11-A are serviced by the main building supply and exhaust ventilation, but additional features are present to increase safety and containment. Supply air to the hot cells is passed through a single HEPA filter before entering the cell. This is to prevent contamination if reverse flow (from the cell to the room) should occur and to reduce dust loading on the first stage of exhaust HEPA filtration. Exhaust from the hot cells is more thoroughly filtered. The 222-SC Filter Building houses five parallel pairs of HEPA filters. These filters provide filtration of hot cell exhaust air before it enters the main exhaust plenum and before final filtering in the 222-SB Filter Building. In total, four stages of HEPA filtration are provided for hot cell exhaust. Figure 3-4 shows the airflow path for the hot cell exhaust.

The hot cell ventilation normally operates as follows:

1. Differential pressure between room and cubicle operating area at -0.5 in. w.g. < DP <-1.2 in. w.g.

2. Airflow through the hot cells sufficient to provide at least seven air changes per hour.

   a. 1-E-1 >30 ft^3/min
   b. 1-E-2 >31.5 ft^3/min
   c. 1-F >61.6 ft^3/min
   d. 1-A >16.8 ft^3/min
   e. 11-A Hot cells >300 ft^3/min.

3. Ventilation having directional flow to the interior of the hot cell with inner transfer door fully open.

4. The exhaust filtration having two stages of leak-testable, fire-resistant HEPA filtration before exhausting to the atmosphere. The HEPA filters must pass an annual DOP test of 99.95% retention of particulates 0.3 μ or larger.

5. The inlet filtration having at least one stage of fire-resistant HEPA filtration with means of controlling inlet air.

Laboratory Fume Hood Ventilation--The laboratory fume hoods are built largely of stainless steel and tempered glass shielding capable of reducing radiation dose rates and eliminating airborne contamination. The laboratory fume hood contamination levels are maintained as low as reasonably achievable (ALARA).

The Laboratory Fume Hood Ventilation System normally operates as follows:

1. The average exhaust flow velocity at the face of an open face laboratory fume hood (face velocity) of >125 linear ft/min and <175 linear ft/min. Hoods not meeting this specification will be readjusted to proper flow by Vent and Balance or immediately taken out of service. Hood airflows are verified monthly.

2. The average exhaust flow velocity at the face of an armported fume hood (face velocity) of >125 linear ft/min and <175 linear ft/min. Hoods not meeting this specification will be readjusted to proper flow by Vent and Balance or immediately taken out of service. Hood airflows are verified monthly.

3. All hoods having two stages of leak-testable, fire-resistant HEPA filtration before exhausting to the atmosphere. One stage of fire-resistant HEPA filtration must be placed as close as practical to the hood to reduce the potential for contaminating exhaust ductwork. The HEPA filters shall pass a DOP test at 99.95% filtration of particles 0.3 μ or greater. All laboratory fume hoods must pass a DOP test annually.

Counting Room Ventilation--The counting room (B-1-A, B-1-F, and B-1-G) and the scanning electron microscope room (B-1-B), located in the basement (Figure 3-3, sheet 3 of 4), are supplied by a supplementary recirculation temperature- and humidity-controlled system. Approximately 80% of the air is recirculated, with 10% lost through louvered doors to the stairwell and 10% used as supply ventilation air for the sample storage stairwell.

This system has two unit air conditioners that maintain the air in the counting room, under routine conditions, at 72 °F and 45.5% relative humidity. This constant condition is required for the proper operation of counting room instruments.

The 219-S Ventilation System--Two separate ventilation systems are used for contaminated areas in the 219-S Waste Handling Facility: an exhaust system for the vault storage tanks 101, 102, and 103 and an exhaust system for the sample gallery.

Exhaust air from the venting of the 219-S vault waste tanks is discharged through the 296-S-16 stack. A demister (tank 105) and a single HEPA filter provide filtration. Airflow through the 296-S-16 stack is about 3.7 m^3/min (130 ft^3/min).

During sampling activities only, ventilation air is exhausted from the sample gallery via an exhaust hood over the sample station, which is connected to a 19.8-m^3/min (700-ft^3/min) exhaust fan that maintains a minimum 38 m/min (125 ft/min) across the open portion of the hood. The exhaust air goes through double HEPA filtration and is discharged through the 296-S-23 stack.

The operating gallery has a very low probability of contamination; therefore, no HEPA filtration is provided. Ventilation enters through two 30.5-cm (12-in.) roof vents or through a swamp cooler if cooling is required.

3.4.2 Electrical Power Distribution

Electrical power to the 222-S Laboratory is supplied by two 13.8-kV lines from the 251-W power station. Should either power line be lost, the switchgear in the 222-S Building closes and automatically transfers to the energized line from 251-W.

3.4.3 Fire Protection

This section describes the fire protection systems for the 222-S Laboratory. The following systems are covered in this section:

- Raw and sanitary water systems
- Fire protection and alarm control panel
- Fire alarms
- Fire detection and control
- 222-SB Final Filter Building
- 2716-S storage building.

Raw and Sanitary Water System--The first-floor sprinkler system in the 222-S Building is supplied with raw water through valve 60 R, which enters on the north side of the facility (Figure 3-5). This is the only raw water supply to the 222-S Building. Raw water is used only for the first-floor sprinkler system.

Other sprinkler systems in the facilities are supplied with sanitary water. The following list outlines the various sprinkler systems and supply valves from the sanitary water loop around 222-S Building (Figure 3-5):

- The second-floor sprinkler system, valve 204S
- The MO-037 trailer, valve 216S
- The 222-SA Standards Laboratory, valve 218S
- The 222-S Annex (maintenance shop), valve 206S
- The 222-S Annex (gas dock), valve 200S
- The 2716-S storage facility, valve 202S.

Fire Protection and Alarm Control Panel--The 222-S Building is equipped with a fire protection and alarm control panel. This system provides a high level of fire protection and multiplexed alarm reporting. It was designed to meet *National Electrical Code*, NFPA 70 (NFPA 1990) requirements.

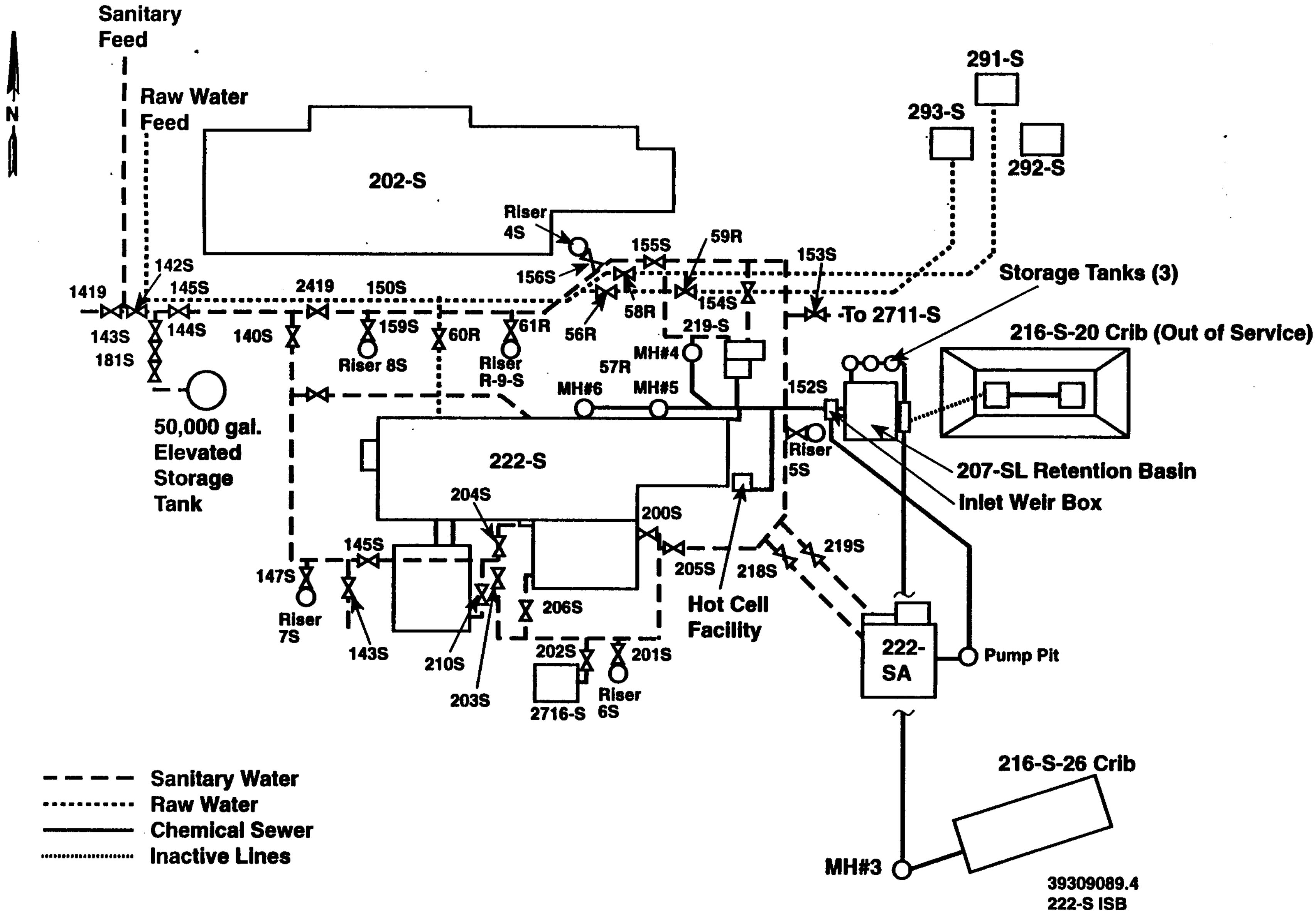

Figure 3-5. Raw and Sanitary Water Supply Systems.

The system is capable of monitoring up to 960 addressable devices, up to 96 zones of 30 nonaddressable detectors, or combinations of the preceding. Addressable initiating circuits allow for connection of up to 30 addressable devices. At present, 102 addressable devices are monitored approximately every 20 seconds for status.

The system's addressable detection devices (ionization or photoelectric) are uniquely addressable, and their sensitivity (response to smoke) can be set and measured by the system's control circuitry. An addressable thermal detector, addressable manual station, and addressable interface module are available. The interface module can be used to interface tamper switches, waterflow switches, etc.

The system is designed so that alarm operation has first priority over all other modes of operation. Should the system lose commercial power, the battery backup will maintain the system for a minimum of 60 hours. The system will be in a trouble mode, which will be acknowledged and reset by the Hanford Fire Department.

Fire Alarms--The 222-S Building fire alarm pullboxes are located throughout all three floors of the building. The majority are located adjacent to the emergency exits. The building has eight zones that alarm to the 200 Area Fire Department via the new radio fire alarm system. Fire gongs are installed in strategic locations on all three floors of the building.

Fire Detection and Control--The 222-S Building is constructed of noncombustible or fire-resistant materials, i.e., concrete with metal partioned walls and 2-hour rated sheetrock walls. Most of the facility is protected with three wet-pipe automatic sprinkler systems. Applicable fire extinguishing capability is provided for each laboratory area depending on the type of fire potential existing therein. Portable fire extinguishers are provided at various locations within the building.

There are six fire hydrants (risers) located around 222-S. Five (4S, 5S, 6S, 7S, and 8S) are on sanitary water and one (R-9-S) is on the raw water system (Figure 3-5). The first-floor sprinkler heads and one fire hydrant are supplied with raw water. The second-floor sprinkler heads, the annex sprinkler heads, and five fire hydrants are supplied with sanitary water. The electrical transformers located on the north wall are protected with a deluge system. Safety showers, provided in the laboratory corridors, also can be used for extinguishing laboratory personnel clothing fires.

The counting room (B1-A, B1-F, and B1-G) and scanning electron microscope room (B1-B) (Figure 3-3, sheet 3 of 4) are provided with a Halon 1301 (bromotrifluoromethane) total flooding extinguishing system, actuated by ionization smoke detectors. The Halon extinguishing system also can be manually released. Smoke detectors connected to the fire alarm system are provided for early detection of fire in rooms B1, B1-B, B1-F, and B1-G. A smoke detector alarm will alert the Hanford Fire Department and building personnel but will not activate the Halon 1301 extinguishing system. The second detector will activate the Halon 1301 extinguishing system after ≈30 seconds and can be manually overridden in case of a false alarm. This 30-second delay will allow personnel sufficient time to evacuate the area.

The sample storage room (2-E) (Figure 3-3, sheet 1 of 4) is equipped with a smoke detector and a CO_2 blanket system. The smoke detector alarm will alert personnel of a fire and will allow sufficient time for personnel to evacuate the area. The CO_2 blanket fire extinguishing system is manually activated. Hot cell 1-E-2 is equipped with sprinklers supplied by water canisters located on the second floor.

222-SB Filter Building--Special consideration is given to the 222-SB Filter Building to prevent fire or excessively hot exhaust gases from reaching the final bank of HEPA filters. This consideration consists of the following three assumptions.

1. The existing sprinkler system in the rooms where the exhaust flow originates or where the duct runs are located would extinguish most of the fire.

2. A fire screen of 16-mesh stainless steel, located at the inlet of the exhaust plenum, would stop burning material that could ignite the filter bank.

3. Dilution in the exhaust plenum of gases from a fire with air from the remainder of the building, coupled with the automatic room sprinklers, would cool the gases from any credible fire to a safe temperature before entering the filter bank.

2716-S Storage Building--This facility is a 158-m^2 (1,700-ft^2) metal building with 18.6 m^2 (200 ft^2) partitioned off for the storage of acids, bases, and other chemicals. It is protected with a dry-pipe automatic sprinkler system, heat detectors, a manual pullbox, and a portable fire extinguisher. The 18.6-m^2 (200-ft^2) hazardous storage area is equipped with explosion-proof lighting, a separate ventilation system, and a fire wall to meet NFPA safety requirements for volatile liquid combustibles. The fire alarm system will alarm at the 222-S Building and send a signal to the 200 Area Fire Station.

3.4.4 Safety and Health Protection

This section describes the installed safety systems or equipment in the laboratory that protect operating personnel from inadvertent exposure to radiation, radioactive contamination, and toxic material. The following topics are included under health protection:

- General laboratory overview
- Airborne contamination control
- Confinement features
- Vacuum air sampling system
- Constant air monitors
- Safety shower locations
- Survey instrumentation
- Safety communications and controls
- 219-S Waste Handling Facility alarm systems
- Annual exposure to laboratory personnel.

General Laboratory Overview--Other than those systems needed for ensuring radiological safety, no laboratory activities are so different from those routinely encountered in many industrial chemical laboratories as to require unusual safety systems. Only safety systems considered to be conventional in the nuclear industry have been found to be necessary and are used in the laboratory to ensure radiological safety.

No laboratory activities are foreseen that cannot be safely terminated either abruptly or within a very short time (a few minutes). The only continuing need during emergency shutdowns is a minimum capacity of ventilation to prevent uncontrolled release of particulate airborne radioactivity to the laboratory environments. The laboratory ventilation system is designed to provide this emergency capacity automatically and would fail to do so only if the nature of the emergency were so catastrophic as to simultaneously impair all electrical power sources and the standby diesel ventilation exhaust fan. Exhaust fan backflow dampers and hot cell inlet air filters provide protection against ventilation backflow. For these reasons, there are no extensive emergency shutdown procedures for the laboratory activities.

Most radioactive materials handled in the laboratory are samples where analyses are needed to support Hanford Site operations (i.e., chemical processing and environmental concerns). In addition, some radioactive materials are used for preparing analytical standards and, on occasion, for bench-scale process testing.

The radioactivity spectrum of materials handled in the laboratory is very broad. Dose rates from most environmental samples are at background radiation levels, whereas dose rates from some process chemical samples can be quite high. Most analytical work is performed on samples having low enough dose rates for safe hands-on handling in fume hoods. Therefore, high dose rate liquid samples submitted to the laboratory are normally diluted in either the hot cells or shielded hood (located in room 2-B) (Figure 3-3, sheet 1 of 4) to radiation levels suitable for fume hood work. Dilution operations are more convenient in this hood than in the hot cells, although the hot cells can handle the more highly radioactive material and larger, more cumbersome radioactive material containers. Liquid samples are received at exterior door 13 to room 2-A of the laboratory (Figure 3-3, sheet 1 of 4) in shielded containers (known as pigs or doorstops) or in polybottles (rigid plastic containers made either of polyethylene or polypropylene). A doorstop carrier weighs about 16 kg (35 lb) and is a cylinder ≈15 cm (≈6 in.) in diameter and 25.4 cm (10 in.) high. The doorstop is made of stainless steel pipe with internal lead shielding. The pig sample carrier weighs between 45 and 68 kg (100 and 150 lb). It is made of stainless steel and uses lead or uranium for shielding. A pig is a cylinder ≈16.5 cm (≈6.5 in.) in diameter and 30.5 cm (12 in.) high.

Solid samples are received in core casks at door 10. The core cask is a special design sample carrier to ship the core segments taken from the waste tanks for waste tank characterization. The core cask weighs approximately 320 kg (700 lb) and is constructed of stainless steel shielded with lead. It is approximately 10 cm (4 in.) in diameter and 122-cm (48-in.) high.

Within the laboratory, lead shielded sample carriers are used to transport 22-ml glass vials of radioactive liquid sample material. The sample or dilution carriers hold two small sample bottles and are equipped with a Tee handle. Dilution carriers weigh about 3.6 kg (8 lb) and are ≈11.4 by 7.6 or 20.3 cm (≈4.5 by 3 in. or 8 in.) high. The dilution carrier is made of lead. These sample carriers are transported in holders (two carriers per holder) on carts. The radioactivity level of the liquid in these vials is normally low enough for fume hood operations.

With the exception of the shielded hood and waste transfer hood, the radiation levels of liquids handled in fume hoods are low enough for safe, hands-on work. Radioactive elements in these liquids are predominantly fission product with only trace amounts of actinides. There are radiation level and size limits on samples diluted in the shielded hood so that the consequences of a spill are limited.

Laboratory radioactive liquid wastes are transferred for disposal to the waste management tank farms via the 219-S Waste Treatment Facility (Figure 3-2). The path for disposal of radioactive liquid waste from the laboratory is through the specially designed "hot" disposal sinks (hood 16, decontamination hood) and the waste transfer hood located in room 2-B (Figure 3-3, sheet 1 of 4). In room 2-B, high-level samples are vacuum transferred in the waste transfer hood to the disposal facility. The aqueous waste flows by gravity from drains in the 2-B sinks through all-welded, corrosion-resistant piping to corrosion-resistant tanks located below ground level in the 219-S concrete vault. In addition to the hot sinks, there are hot cell drains so that aqueous hot cell waste can be discharged directly from the hot cells to waste tanks in 219-S. The underground portion of the transfer piping and the few piping connections are enclosed in concrete casing to ensure aqueous waste containment should a leak occur. Heavy concrete shielding blocks are used to cover the concrete vault. Piping connections to the tanks are above maximum liquid levels to avoid potential tank leaks.

The following precautions are taken to ensure confinement of radioactive liquids within the laboratory.

- Radioactive liquids are transported in closed, nonleaking containers. The containers of liquids with significantly high dose rates are additionally enclosed in the following shielded containers:

  - Pigs
  - Doorstops
  - Sample carriers
  - Core casks.

- Containers of radioactive liquid are opened, and the contents are exposed only in hoods or hot cells. The hood walls and laboratory ventilation system serve as the containment barriers for airborne contamination from exposed radioactive liquids in the hoods. The hot cell shielding walls and inlet and outlet HEPA filters are the hot cell containment barriers for particulate airborne radiation.

- Isolated, high-integrity, corrosion-resistant piping and receiving tanks are the first containment barrier for radioactive aqueous waste in transit to and at the 219-S Waste Treatment Facility. All welded piping is used within the laboratory building. The underground piping is double contained, and the receiving tanks are enclosed in a concrete vault for secondary containment. The use of welded connections for the underground piping and receiving tanks is maximized. Flow from the laboratory drains to the receiving tanks is by gravity. The aqueous waste is transferred between tanks within the 219-S vault and from the 219-S Waste Treatment Facility with steam jets using 620.5-kPa (90-lbf/in^2 [gauge]) steam. The use of low-pressure steam jets for these transfer operations avoids the use of pumps, which require rotating shaft seals (potential leaks), and limits the internal pressure of the transfer pipeline to 620.5 kPa (90 lbf/in^2 [gauge]), which is well below the maximum allowable pipe stress.

- Laboratory aqueous wastes, potentially contaminated with hazardous waste or radioactivity (other than sanitary waste), flow by gravity and accumulate in concrete retention basins at the 207-SL Facility (Figure 3-5). This waste is unconditionally released to the environment only after tests show that the pH is correct and radioactive content is below release criteria; otherwise, the waste is pumped through 219-S to the waste management tank farms for disposal as radioactive aqueous waste. Waste streams are analyzed to determine pH, alpha, and beta content to ensure these parameters are within acceptable ranges. Through the use of administrative procedures, radioactive contamination in this waste is low. Monthly composite samples of releases from 207-SL are analyzed for americium, plutonium, strontium, total alpha, total beta, gamma energy, pH, and total organic carbons for reportable concentrations.

<u>Airborne Contamination Control</u>--Two methods are used in the 222-S Building to prevent release of airborne radioactivity to the environment or to laboratory work areas. One method depends on the existence of physical barriers between the material (or atmosphere) containing radioactivity and the areas where personnel are permitted. The other method depends on the ability of the building ventilation system to channel all air through HEPA filters having high enough efficiency to lower the particulate radioactivity in the air to less than the criteria guidelines in WHC-CM-7-5, *Environmental Compliance*. There are no design provisions for removing gaseous radioactive species from the air. To exceed the Derived Concentration Guide for airborne radioactivity, ≈500 to 1,000 of the highest radioactive laboratory samples would have to be totally volatilized in 1 year.

Physical barriers for airborne contamination control may be either partial or total and either single or multiple layer. Examples of total physical containment barriers in the laboratory are tightly closed sample containers and the hot cells. All hoods are examples of partial, physical containment barriers.

In radiological facilities such as the laboratory, primary ventilation systems normally ensure the following.

- The air within the worker-occupied areas of the facility is both healthful and comfortable for the facility occupants.
- Areas within the laboratory that are occupied by personnel are maintained free from airborne contamination such that no radioactivity is released to the environment in excess of the release criteria guidelines.

<u>Confinement Features</u>--Specific structures for the confinement of radioactivity in normal operation are the hot cells, shielded hoods, and shielded sample dilution stations.

Hot cells, also referred to as cubicles or shielded caves, are thick walled enclosures located in rooms 1-A, 1-E, 1-F and 11-A. Walls are a minimum of 20.3 cm (8 in.) thick and provide shielding to permit operations involving high-level samples. Separate ventilation is provided, and the hot cells are maintained at a negative pressure with respect to the room. Drains in the hot cells route liquid waste to the 219-S Waste Handling Facility.

Shielded hoods are facilities for handling intermediate-level samples. A sash window with access ports is provided, and ventilation is designed to provide a face velocity of 125 linear ft/min. Sufficient shielding is provided to reduce the radiation level of 2 rem/h within the hood to 5 mrem/h outside. Shielded hoods are located in room 2-B (Figure 3-3, sheet 1 of 4).

Room 2-B contains one sample dilution station. The sampling device is remotely operated and capable of transferring microliter amounts of high gamma-emitting sample from sample carriers to dilution carriers. Portable, transparent shielding is set on a turntable to enable access inside the hood. The shielding can reduce radiation levels of 7 rem/h in contact inside to 0.5 mrem/h outside.

Special equipment providing confinement are the sample carriers, dilution carriers, and sample storage units. The sample carriers are of several types and provide the bulk of the shielding. The sample carriers used most are the doorstop and pig.

The room 2-B sample storage units consist of 48 compartments shielded with lead plate on the sides and top. These units are used to store samples awaiting analyis. These storage compartments provide directional airflow over the samples to minimize an accidental loss of containment.

<u>Vacuum Air Sampling System</u>--The vacuum air sampling system currently provides about 70 open-face, filter-paper record air samplers located in laboratory rooms, hallways, and service tunnels of the 222-S Building. At least one air sample per week from each location is analyzed for alpha and/or beta-gamma radioactivity. The analyses are reviewed by radiation monitoring personnel to ensure that the radioactive concentration of the air at various locations remains ALARA. Two vacuum air sampling pumps provide vacuum for the

VAS system and continuous air monitors (CAM). A current list of fixed-head air samplers can be found in the instrument inventory list, generated per WHC-CM-8-7, *Operations Support Services*, "Component Based Recall System".

Air Monitoring--Combination beta-gamma CAM units and alpha CAM units are found throughout the 222-S Building. The CAMs are placed in the various locations according to the potential for airborne radioactivity determined by Operational Health Physics. All the CAM units alarm locally. A current list of 222-S Building CAMs can be found in the instrument inventory list, generated per WHC-CM-8-7. A list of permanently installed CAMs is given in Table 3-1.

Table 3-1. Location of Continuous Air Monitors at the 222-S Laboratory Facility.

Location (room No.)	Type	Monitoring
1GB	Alpha	1GB
2nd floor	Alpha	296-S-21 stack
2nd floor	Beta-gamma	296-S-21 stack

The gaseous effluent from the main 296-S-21 stack of the 222-S Building (Figure 3-4) is continuously monitored and sampled. Samples are analyzed to determine the quantity of radioactivity released to the environment. Constant air monitors are installed to detect and record the rate of release of beta-gamma and alpha radioactivity via the stack discharge. Monitor failures or above-normal gaseous effluent discharges will activate remote alarms in rooms 5-A and 3-B (Figure 3-3, sheet 1 of 4).

Gaseous effluent from the 296-S-16 stack, which exhausts the 219-S vault and waste tanks, is sampled and analyzed weekly to determine the quantity of beta-gamma and alpha radioactivity released to the atmosphere. A low sample flow rate will activate remote alarms in 219-S and in room 3-B of 222-S. Because of the extremely low use factor, the discharge from stack 296-S-23, which exhausts the 219-S sample gallery, is not monitored.

Safety Shower and Eyewash Locations--The 222-S Laboratory is equipped with safety showers at various locations for use if inadvertent exposure to hazardous chemicals occurs. Locations of safety showers are listed in Table 3-2. Eyewash stations at the 222-S Laboratory are installed per OSHA requirements at most safety shower locations.

The 222-SA Laboratory has four combination safety shower/eyewash locations. Two safety shower/eyewashes are located in the standards laboratory and two are located in the research laboratory.

Table 3-2. Location of Safety Showers at the 222-S Laboratory.

Location
Inside 219-S
Outside 219-S
HNO_3 Tank outside 222-S
HNO_3 Tank inside 222-S*
Outside 2716-S storage building*
Corr 8B outside 1K*
Corr 8A outside 1A*
Corr 8F outside 4M*
Corr 8F outside 4K*
Corr 8F outside 4J*
Corr 8H outside 4V*
Corr 8H outside 4P*
Corr 8H outside 4S*
Corr 8D outside 2D*
Corr 8C outside 2H*
Room 2-B (decon hood)
Room 2-B (west wall)*
Outside tunnel T-4
Outside tunnel T-7/T-8

*Eyewash stations are installed per Occupational Safety and Health Administration requirements at these safety shower locations.

Survey Instrumentation--Survey instruments for detecting beta-gamma and alpha contamination are set at step-off pad locations in hallways and exits from designated laboratory rooms. The instruments permit early detection of personnel contamination and minimize the potential for spread of contamination to "clean" zones. All personnel are required to wear multichip thermo-luminescent dosimeters and certain personnel are further required to wear finger rings and pencil dosimeters to measure accumulated personal radiation exposure. Combination alpha-beta-gamma hand and foot counters for detecting low-level alpha and beta-gamma are located at the west entrance of the building, at the entrance to the counting room, and in the airlock exit to trailer MO-037. All personnel that have been in a radiation zone are required to survey before leaving the zone.

The fissile material inventory in the 222-S Building is administratively limited to less than one-third of a minimum critical mass, and the building is classified as an isolated facility. Therefore, no criticality accident alarms are required. The facility is operated in compliance with administrative controls and criticality prevention specifications for the isolated facility classification.

Safety Communications and Controls--The 222-S Laboratory communications systems consist of the following:

- Plant, cellular, or outside telephone system
- Internal (PAX) dial-type telephone system
- Internal paging system
- Emergency evacuation audible alarm system
- Fire alarm system.

The plant, cellular, or outside telephone systems are commercial telephones that provide outside communication for all primary control locations and offices allocated to personnel within the 222-S Laboratory. The plant and outside system are also tied to the area "CRASH" alarm system on 373-2435.

The PAX telephone system provides internal paging and communication within the 222-S Laboratory. By dialing 990, the PAX systems at the 222-S Building and associated facilities, including 202-S, are activated, and a person being paged can be instructed to call a specified station, or emergency information can be transmitted.

The emergency evacuation audible alarm systems are described in WHC-IP-222S, *Building Emergency Plan for 222-S Laboratory Complex*. The fire alarm system is described in Section 3.4.3.

Liquid Level Alarm Systems--High liquid level alarms are installed in the 207-SL retention basin, 219-S tanks, and 219-S sumps. When the liquid reaches a certain height, an annunciator light is activated in 219-S and in room 3-B of 222-S Building. High liquid level alarms also are installed on the hot tunnel sumps and the cold (regulated) tunnel sumps. The hot tunnel sumps alarm in the S-3D control room, and the cold tunnel sumps alarm in room 3-B. These alarms, when activated, are acknowledged by 222-S Laboratory operating personnel who then take appropriate corrective action.

3.4.5 Waste Management Systems

This section describes the configuration and operation of the chemical sewer system and the radioactive liquid waste system in the 222-S Laboratory Facility.

Chemical Sewer System--The 222-S Laboratory chemical sewer handles water flushes, steam condensate, cooling water, and other liquid streams that have a low potential to contain radioactive contaminants or hazardous chemical waste (refer to Figure 3-5).

The chemical sewer consists of a main concrete-encased vitrified clay pipe (VCP) that extends south of the 222-S Building and underneath the 222-SA Building to manhole No. 3 (Figure 3-5). The VCP then runs about 9 m (30 ft) east to the 216-S-26 crib. The 216-S-26 inlet is approximately 195 m (640 ft) south and 52 m (170 ft) east of the 222-S Building and is located outside the 200 West Area exclusion area fence. For the period January through December 1992, the average flow rate to the 216-S-26 crib was ≈46,575 L/d

(≈12,055 gal/d) with a pH range of 6.12 to 9.96. The average alpha and beta concentrations for this period were 3.1 10^{-12} Ci/L and 7.9 10^{-12} Ci/L, respectively.

Effluents from the 222-S Building, 222-SA Standards Laboratory, 291-S steam turbine, and 219-S operating gallery are routed to the 207-SL retention basin (Figure 3-5). The effluent is sampled at the 207-SL inlet weir box and verified to be within release limits before transfer to the 216-S-26 crib.

207-SL Retention Basin--The 207-SL retention basin acts as a temporary holding facility for potentially radioactive or hazardous liquid effluents for the 222-S Laboratory before discharge to the 216-S-26 crib. Effluents from the 222-S Building and 219-S facilities are transferred to the 207-SL retention basin inlet weir box via a fiberglass-reinforced pipe (FRP) enclosed in a concrete-encased VCP. This line is fed by another FRP enclosed in a concrete-encased VCP from manhole No. 4 (219-S Facility), a stainless steel retention waste line and a carbon steel coolant and condensate drain at manhole No. 5 (222-S Building multicurie section), and a stainless steel retention waste line and 7.6-cm (3-in.) carbon steel condensate drain at manhole No. 6 (222-S Building analytical section) (Figure 3-5). Effluent to the basin is sampled automatically (by a grab-proportional sampler) at the inlet weir box and must be verified to be within *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* and *Resource Recovery and Conservation Act of 1976* pH release limits before being transferred to the 216-S-26 crib by a VCP. The 216-S-20 crib is located directly east of 207-SL. The 216-S-20 crib has been permanently removed from service, but there is an existing line running to 216-S-20 from 207-SL. This crib was formerly used for disposal of low-level radioactive waste. The line to the 216-S-20 crib is valved closed and locked.

222-SA Standards Laboratory--Nonhazardous effluents from the laboratory sinks, fume hoods, and glass washer are discharged to a polyvinyl chloride pipe drain. This line then discharges to a 757-L (200-gal) lift station pump pit. The collected effluent is automatically pumped to the inlet weir box at the 207-SL retention basin (Figure 3-5). Water from the kitchen, restrooms, and vacuum pump cooling goes to the sanitary sewer.

219-S Hot Waste Facility--Operating gallery sump No. 8 and steam condensate from the operating gallery empty into a stainless steel utility drain. Steam condensate from cells A and B steam heaters connects to a stainless steel condensate drain. Both the lines run west out of the 219-S Building to manhole No. 4 (Figure 3-5) where they connect to a FRP. This FRP runs inside a concrete-encased VCP to another FRP running inside a concrete-encased VCP. This line in turn empties into the 207-SL retention basin.

222-S Drain System Description--The 222-S Building (Figure 3-3) can be divided into two sections; the analytical section occupies the western side of the building, and the multicurie section occupies the eastern side. The analytical section retention basin effluents go to two drain lines in the basement tunnels. The multicurie section retention basin effluents go to two different drain lines in the basement tunnels.

<u>Basement Tunnels</u>--All effluents from the 222-S Building to the 207-SL retention basin are discharged through four different lines; a stainless steel retention basin waste line and carbon steel coolant and condensate line for the analytical section and a stainless steel retention basin waste line and a carbon steel steam condensate drain for the multicurie section.

Cold tunnel sumps 1, 2, 3, 4, 5, and 6 discharge into the analytical section retention basin waste line. All sumps act as floor drains for the tunnels. Sump No. 5 is also fed by a floor drain in a stairwell outside 222-S, near door No. 19, on the north side of the building. The analytical section retention basin waste, coolant, and condensate lines run north out to manhole No. 6 (Figure 3-5) where they flow into a FRP to the 207-SL retention basin inlet weir box.

Cold tunnel sump 7 acts as a floor drain in the east end of the cold tunnels but is also fed by a floor drain outside door No. 18. Sump 7 discharges to the multicurie section stainless steel retention basin waste line. The sump in hot tunnel T-7 (Figure 3-3, sheet 3 of 4) normally is pumped to the 219-S Hot Waste Facility; however, a three-way valve on the sump discharge allows for transfer to the retention basin waste line. The three-way valve to the 207-S retention waste is located inside tunnel T-7 and is switched manually, which requires special entry and happens only in an unusual event. Steam condensate from the 222-S Building main steam line flows into the multicurie section condensate line. The two lines exit the north side of the building to manhole No. 6. At manhole No. 6 the lines connect into a FRP going to the 207-SL retention basin inlet weir box.

<u>First-Floor Analytical Section</u>--All analytical section laboratory sinks and hood condensate drains, except in rooms 2-B and 2-B-2, go to the retention basin waste line. The laboratory hood drain in 2-B-2 and all drains in 2-B go to the 219-S Hot Waste Facility. All analytical section service sinks and the floor drains in rooms 2-F and 2-G go to the analytical section retention basin waste line.

<u>First-Floor Multicurie Section</u>--Generally, all multicurie section (Figure 3-3, sheet 1 of 4) laboratory sinks and a hood condensate drain in room 1-L go to the multicurie section retention basin waste line.

<u>Second-Floor Equipment Room</u>--The sink and glass saw drains in the glass blowing shop, room S3-E (Figure 3-3, sheet 2 of 4), go to the analytical retention basin waste line.

The distilled water overflow and drain lines, second-floor steam condensate, firewater sprinkler system drain, hot water generator tank No. 20 overflow and drain, backflush and drain from Millipore deionized water unit, a floor drain near the Millipore unit, and the flash tank overflow and drain lines all go to the analytical section coolant and condensate line. Lines into the flash tank include cooling water from the supply fans wet glass cell air washers, condensate from booster coils, and condensate from the reheat and preheat coils on supply fans.

A floor drain on the second floor in room S1A goes to the multicurie section retention basin waste line.

<u>French Drains</u>--Several french drains for steam condensate serve the 222-S Laboratory. These drains serve as condensate drains for the main steam supply lines at the 222-S Laboratory. The french drains discharge directly into the ground instead of the 207-SL retention basin. Only steam condensate from steam lines that have not entered radiation zones is allowed to be discharged to these drains and, as such, is not considered to have a potential for contamination.

<u>Chemical Sewer Sampling</u>--The chemical sewer stream is sampled via a flow proportional automatic sampler. In cases when the sampler is inoperative or for cross-checking analyses, grab samples can be taken directly from the retention basins. The samples are analyzed for total alpha, total beta, and pH. The effluent is transferred to the 216-S-26 crib. If the effluent were found to be out of specification, an alternate method of disposal would be required and determined at the time.

<u>Emergency Actions and Procedures</u>--Emergency actions and procedures for chemical sewer handling are listed below:

1. *Report Chemical and Radiological Spills and Discharges*, July 1993, (Procedure LO-190-131)

2. *Sample and Transfer 207-SL Retention Basin Liquid Waste*, March 1993, (Procedure LO-100-167)

3. *Use of Laboratory Sinks and Drains*, August 1993 (Procedure LO-161-145)

4. *Non-Rad Hazardous Chemical Waste Disposal at 222-S Facilities*, January 1993, (Procedure LO-100-056)

5. *Building Emergency Plan for 222-S Laboratory Complex*, March 1988 (WHC-IP-0263-222S)

6. *Analytical Chemistry Services Laboratory Operating Instructions*, 1993 (WHC-CM-5-4).

<u>Radioactive Liquid Waste System</u>--This section describes the design and operation of the radioactive liquid waste system for the 222-S Laboratory Facility. All waste in this system generated in the 222-S Laboratory is classified as low-level waste. Within this classification, the laboratory procedures reference the waste as high-level, intermediate-level, and low-level depending on sample concentrations.

From the laboratory, hot sink drains, and hot tunnel sumps, radioactive waste flows or is jetted (slurped) to the 219-S Waste Handling Facility via four stainless steel lines. These lines are encased in concrete pipe trenches from the point of exit from the 222-S Building to entry into the 219-S vault. High-level waste goes to tank 103, and intermediate-level and low-level waste goes to tank 101. Waste from tanks 101 and 103 is jetted to tank 102 for neutralization. The waste is transferred to a tank truck or is jetted through jumpers in the 202-S D-Cell to the tank farms.

Process Description--Intermediate-level and low-level radioactive liquid wastes are generated from decontamination hood No. 16 sinks, the room sink in room 2-B, room 2-B-2 hood, the inductively coupled plasma spectrometers in room 1-J, the room sink and hood in room 1-A, and the room 11-A hot cells. This waste is routed to tank 101 in the 219-S vault (Figure 3-2) via two stainless steel lines. The lines are encased in a concrete pipe trench from the point of exit from the 222-S Building to entry into 219-S. The waste in hot tunnel sumps T-8 and T-4 also can go to tank 101, but normally goes to tank 103 (high-level radioactive waste).

High-level radioactive liquid wastes are generated from laboratory operations in the hot cells in rooms 1-A, 1-E (hot cells 1E-1 and 1E-2), and 1-F; the manipulator repair hood in 1-F; the atomic absorption spectrophotometer in room 1-K; the slurpers of decontamination hood No. 16 in room 2-B; and tunnel sumps T-4, T-7, and T-8. This waste is routed to tank 103 in the 219-S vault via a stainless steel line. This line also is encased in a concrete pipe trench. Tunnel sump T-7 also has the capability to go to the 207-SL retention basin, while sumps T-4 and T-8 can be diverted to tank 101.

The 219-S Waste Handling Facility is an isolated facility (WHC-CM-4-29) consisting of an 8.2-m by 7.8-m (27-ft by 25.5-ft) enclosed, below-grade, concrete vault containing three stainless steel tanks; a 6.7-m by 4.0-m (22-ft by 13-ft) transit building; the pipe trench and operating gallery; and an attached concrete-walled sample gallery. The three vault tanks are vented by an electrical exhaust fan, through a deentrainer or demister and a HEPA filter, and to the atmosphere via the 296-S-16 stack.

Waste batches in tanks 101 and 103 are transferred to tank 102 in the 219-S vault where they are sampled and analyzed for radioactivity and pH and batch transferred through the 202-S D-Cell to diversion box 241-S-151 in the 200 West Area tank farms or transferred via tank truck.

Any leakage from the waste lines to the concrete pipe trenches drains to the 219-S vault, sump 6 in cell B, which has liquid-level measurement and alarm capability for leak detection. Leakage to sumps will sound an alarm in room 3-B of 222-S and to the 219-S operating gallery. Overflows from tank 103 are collected in sump 6, and overflows from tanks 101 and 102 are collected in sump 7 in cell A. Steam jets are used to transfer waste back to the respective tank.

Process Technology--All tanks are operated below the overflow limit. If there is an overflow, the waste is jetted back to the respective tank. However, recirculating waste consumes steam and manpower and adds considerable heat to the aqueous waste, which in turn causes inefficiency due to the gassing out of steam transfer jets. Therefore, some liquid is allowed in the sumps, but the amount is limited to 15.2 cm (6 in.). This limit is set to keep the amount of waste in the sumps to a minimum because concrete is the only barrier between the waste and the environment. Tanks 101 and 102 have working capacities of 13,630 L (3,600 gal). Tank 103 has a working capacity of 4,770 L (1,260 gal). These limits are set to prevent overflows and allow for caustic and nitrate additions.

There are several requirements for the liquid waste handled by the 222-S Laboratory. No separable organic phase or emulsions are allowed in the liquid waste. To protect the piping and the tanks, no hydrochloric acid or materials detrimental to 304 steel are allowed in the liquid waste without prior neutralization or thorough flushing of the lines for at least 2 minutes. Permission from the functional unit manager must be granted before any strong oxidizing or reducing chemicals can be released to the liquid waste. Liquids with exotherm below 232.2 °C (450 °F) or a flashpoint below 65.5 °C (150 °F) are not allowed in the liquid waste. The total amount of fissile material in the liquid waste in the 219-S vault is limited to 177 g. The temperature of the waste is limited to 93.3 °C (200 °F). Before the waste can be transferred to tank farms, the pH must be >12, and the nitrate concentration must be at least 600 ppm. The pH and nitrate conditions will slow the rate of storage tank corrosion. Refer to operating specifications documents (OSD-S-186-00002, "Hot Cell Operations;" OSD-S-186-00003, "222-S Waste Management Laboratory Hood;" and OSD-S-186-00004, "219-S Waste Facility," for more detailed descriptions of the aqueous waste.

Process Control--Waste overflows are mitigated by use of weight factor recorders, liquid level indicators, and photohelics. Charts have been developed to show the correlation between the weight factor readings and the gallons of waste in a tank. Because the capacity of the tanks is known, the charts are used to avoid overflows. Also, all tanks, the hot tunnel sumps, and the 219-S sumps have lighted and audible alarms to indicate when the liquid-level limit is exceeded. The alarms for the tanks and the 219-S sumps are located in room 3-B of the 222-S Building and the 219-S operating gallery. The only alarms for the hot tunnel sumps are located in the power control room of the 222-S Laboratory. The plutonium, organic solids, pH, and sodium nitrite limits of plant waste are regulated through tests, analyses, and chemical treatments. The pH is controlled by use of 50% NaOH solution.

3.4.6 Solid Waste Management

Solid waste consists primarily of laundry, rubber gloves, paper, plastics, glass vials, and failed or replaced HEPA filters. The primary radioactive contaminants in the 222-S Laboratory solid waste are fission products. Laundry is collected daily and stored in a temporary storage shed on the north side of the 222-S Building (Figure 3-2). It is usually not contaminated. The glass vials, rubber gloves, paper, and plastic must be disposed of in accordance with WHC procedures. These wastes are usually low-level radioactive wastes. Solid waste that is preliminarily designated transuranic waste is transferred to the PFP for disposal.

Low-level radioactive solid effluents (e.g., paper, plastics, small equipment) are packaged in plastic bags and stored in plywood burial boxes in a controlled area located adjacent to the north side of the 222-S Building. When full, the boxes are transferred to the 100-N Area for waste compaction. The compacted waste is packaged and buried in accordance with WHC procedures.

Laundry, although usually not contaminated, is monitored, and any found to be contaminated is handled in accordance with WHC procedures.

Failed or replaced HEPA filters must be packaged and buried in accordance with WHC procedures.

Radioactive mixed wastes are segregated from radioactive and hazardous wastes and are handled in accordance with applicable procedures.

Transuranic wastes, which is estimated at about 5 ft^3/yr, is handled in accordance with WHC-EP-0063-4 (Willis 1993).

3.4.7 Hazardous or Radioactive Material Inventory

The hazardous chemical inventory of the 222-S Building and 222-SA Laboratories is provided in Table 4-11, "Extremely Hazardous Substances." These chemicals are listed as either dangerous or extremely hazardous by the Washington State Department of Ecology.

3.4.8 Environmental Considerations Overview

Airborne, solid, and liquid radioactive wastes are generated by operation of the 222-S Laboratory. Airborne and solid effluents are generally low-level radioactive wastes. Liquid waste is both low- and high-level radioactive wastes. Airborne, solid, and liquid wastes also may contain low concentrations of nonradiological, potentially hazardous, chemical waste from laboratory operations.

Objectives for managing effluents from the operation of the 222-S Laboratory are (1) liquid and airborne environmental effluents discharges shall be managed per the guidelines in WHC-CM-7-5, and (2) solid waste shall be managed per the guidelines in WHC-EP-0063-3 (Willis and Tiner 1991).

Resource Conservation and Recovery Act-Interim Status Requirements for Normal Facility Operation--Both general administrative requirements that are applicable to all Hanford Site facilities and facility-specific management requirements are discussed by Lerch (1988).

The general requirements cover topics including the following: facility ownership, permits, waste identification and verification, waste analysis, site security, inspections, remedial action, personnel training, records, equipment maintenance, contingency plan, emergencies, manifest discrepancies, reports, accident prevention, labeling requirements, and Part A permit limitations. Details of requirements relative to these topics may be found in the reference and are too voluminous to include here.

The facility-specific requirements for the waste tanks include preparation and maintenance of a written closure plan that contains the following:

- A description of how final closure will be conducted, identifying the maximum extent of the operation that will be unclosed during the active life of the facility
- An estimate of the maximum inventory of hazardous wastes

- A description of the steps to remove or decontaminate all hazardous waste residues
- A description of monitoring activities
- A closure schedule
- An estimate of the final year of closure.

The requirements also specify post-closure care that includes security, maintenance, monitoring, and reporting requirements. These items must be described in a post-closure plan.

In addition to facility closure requirements, there are general facility operating requirements that include daily inspection of waste tank systems and required response to leaks or spills. Secondary containment is required for any new hazardous waste tanks (and piping), and rules are provided on the timing requirements for retro fitting secondary containment on existing waste tanks and piping.

The facility-specific requirements for the waste tanks also include conducting annual tank integrity assessments for existing tanks that do not have secondary containment. These annual assessments must be done until the storage tanks are provided with secondary containment.

Resource Conservation and Recovery Act-Part B Permit--The 222-S Laboratory along with 62 other Hanford Site facilities will eventually be covered by a Part B permit. Application for this permit was made in 1992. The Part B permit will include all other pertinent environmental requirements, such as hazardous air emissions, as components of the Part B permit.

4.0 ACCIDENT ANALYSIS

This chapter presents a range of potential abnormal and accident conditions (preliminary hazards analysis [PHA]) that could occur over the operational lifetime of the 222-S Laboratory. Bounding accidents are selected (by release mechanism) from the PHA for each facility and described in greater detail. The accident analysis, through projected dose or exposure comparisons to the appropriate criteria, substantiates the facilities' designation of low hazard or Category 3 under DOE Order 5480.23. The accident analysis also provides the basis for the safety equipment list.

Although the functional facilities are collocated, it is not considered credible for initiating events from one building to create upset conditions in another building because of low energy, low-inventory processes, and fire suppression systems. This chapter uses the graded approach concept safety analysis report for a Category 3 facility as specified in DOE Order 5480.23 from the guidance contained in DOE-STD-1027-92, *Hazard Categorization and Accident Analysis for Compliance with DOE Order 5480.23, Nuclear Safety Analysis*, (DOE 1992).

The following facilities were considered in the accident analysis:

- 222-S Building
- 222-SA Standards Laboratory
- 222-SB Filter Building
- 222-SC Filter Building
- 222-SD Solid Waste Handling and Storage System
- 222-SE Filter Building
- 207-SL Retention Basin
- 219-S Waste Handling Facility
- 2716-S Storage Building.

The following events have been selected from the PHA and are discussed further as accidents:

- Bounding worst-case accident (Section 4.3)
- Earthquake (Section 4.6.1)
- Spills (Section 4.6.2)
- Fire (Section 4.6.3)
- 219-S Coverblock Drop (Section 4.6.4)
- Vehicle-Induced Spills (Section 4.6.5).

4.1 RECEPTOR LOCATIONS

The hypothetical maximum onsite individual is defined in accordance with WHC-CM-4-46 as a receptor located at the distance and direction from the point of release at which the maximum dose occurs. This analysis considers the onsite receptor as a site worker located 900 m northwest at the 242-S Evaporator. This location is the nearest occupied facility where in the event of a release from the 222-S Laboratory a facility worker would receive the maximum dose.

The hypothetical maximum offsite individual is a receptor located at or beyond the site boundary location for which offsite consequences are calculated. This analysis considers this receptor to be located 13.5 km west from the 222-S Laboratory.

4.2 SUMMARY OF SELECTED ACCIDENT SCENARIOS

The results of the accident analyses are summarized in Table 4-1.

Table 4-1. Consequences of Selected Accident Scenarios.

Accident category/type	Exposure units	Consequences[a]		Guidelines[b]	
		Onsite	Offsite	Onsite	Offsite
Bounding "Worst-Case" Accident					
0.25g Earthquake and fire	50 yr EDE (rem)	2.48	0.056	≤5	≤0.5
	(ppm)	3.7	0.082	15 (ERPG-2)	2 (ERPG-1)
Preliminary Hazard Analysis Based Accidents					
0.12g Earthquake		Localized consequences limited to facility worker (Section 4.6.1)	N/A	N/A	N/A
Filter fire	50 yr EDE (rem)	2.6 E-03	5.7 E-05	≤5	≤0.5
Dropped cover block	50 yr EDE (Rem)	2.0 E-03	4.4 E-05	≤5	≤0.5
Vehicle-induced accidents (chemical spill)	(ppm)	0.15	3.3 E-03	15 (ERPG-2)	2 (ERPG-1)

[a]Dose and exposure consequences analysis are provided in Appendix C.
[b]Taken from WHC-CM-4-46.
ERPG = Emergency Response Planning Guidelines (AIHA 1991) values shown are nitric acid.
N/A = Not Applicable.

4.3 BOUNDING WORST-CASE ACCIDENT FOR THE 222-S LABORATORY FACILITIES

4.3.1 0.25g Earthquake and Fire

The original structures of the 222-S Laboratory were constructed during 1950 and 1951 to the building codes current for that time period (refer to Chapter 3.0). Seismic analyses of the Plutonium Finishing Plant, built in the same approximate time frame, indicate that the plant would not withstand the 0.25g horizontal and 0.17g vertical forces of an earthquake (Marusich 1988) (Category 2 facility criteria, DOE-STD-1027-92). The 222-S Laboratory would be equally affected, and this scenario represents a beyond-design-basis accident analysis.

Although the probability of the 0.25g earthquake is considered extremely unlikely (i.e., $<1 \times 10^{-4}$ per year), the seismically induced loss of structural integrity, loss of associated utilities, building collapse, and ensuing fire is the perceived mechanism for the maximum release of hazardous materials, both radiological and chemical. The design requirements for the initial construction of the 222-S Laboratory are discussed in the *222-S Laboratory Facilities Hazards Identification and Evaluation* (Williamson 1989). Because the facilities have not been evaluated to the new criteria (i.e., design criteria revisions since the design of the facility), it is assumed that the facilities do not meet the current criteria. However, despite the fact that the facilities do not meet the design criteria, it is concluded in the accident analysis that the facilities can be operated safely. This event is considered the bounding accident for all the 222-S Laboratory and includes all collocated facilities in the 222-S Laboratory.

4.3.1.1 Accident Scenario. An earthquake approaching or exceeding 0.25g is postulated to occur on the 200 Areas plateau. The 222-S Laboratory begin to rock and sway. Utilities within the facilities begin to fail. Flammable gases are released into the facilities, electrical lines are cracked and severed, laboratory reagents and standards are released from broken containers, and laboratory samples are likewise released from their containers. Walls and structural supports buckle; ceilings and roofs collapse. The sparks from loosed electrical utilities, scraping metal surfaces, or ignition sources from chemical incompatibilities ignite flammable gases and flammable laboratory solvents and initiate a complex-wide consuming fire. Throughout the course of the fire, hazardous material inventories are either released to the environment or consumed through combustion and oxidation.

4.3.1.2 Source Term.

4.3.1.2.1 Radiological. The 222-S Laboratory inventory used in this accident analysis was developed in the hazard categorization for the facility (Bourger 1993b). Average values for each radionuclide were calculated from samples collected during tanker truck transfer pumping (from February 1992 to June 1993) at the 219-S Waste Handling Facility to determine average concentrations. The average concentrations per gram are multiplied by a maximum sample mass of 625 g (one core equivalent sample or 100 dilute analytical sample [Bourger 1993b]) and a dilution factor of 50,000 to obtain the maximum activity of a single sample. That value is multiplied by the maximum number of samples received and stored to derive the maximum facility inventory. Based on conversations with facility personnel, it is anticipated that a maximum of 800 samples (received and stored) would be within the facility during normal operations. The ^{239}Pu amount is chosen to be 11 Ci, because the facility is designated an isolated facility (i.e., limited to one-third critical mass). This approach for deriving the source term is conservative.

Table 4-2 lists the more frequently sampled range of radionuclides, the maximum facility activities per radionuclide, and the amount available for release upon applying the release fractions.

Table 4-2. 222-S Laboratory Radionuclide Source Term.

Radionuclide	Ci/200 samples	Release fraction*	Source term
^{3}H	4.08 E+00	1.0	4.08 E+00
^{14}C	1.28 E-01	1.0	1.28 E-01
^{60}Co	8.64 E+00	5.0 E-04	4.32 E-03
^{90}Sr	5.00 E+02	5.0 E-04	2.50 E-01
^{99}Tc	1.06 E+00	5.0 E-04	5.28 E-04
^{129}I	9.32 E-01	1.0	9.32 E-01
^{137}Cs	1.26 E+03	5.0 E-04	6.32 E-01
^{147}Pm	1.52 E+02	5.0 E-04	7.60 E-02
^{238}Pu	4.36 E-01	5.0 E-04	2.18 E-04
^{239}Pu	1.10 E+01	5.0 E-04	5.50 E-03
^{241}Am	2.40 E+00	5.0 E-04	1.20 E-03
^{234}U	3.90 E-01	5.0 E-04	1.95 E-04
^{235}U	1.14 E-02	5.0 E-04	5.72 E-06
^{238}U	2.66 E-02	5.0 E-04	1.33 E-05

*Taken from Mishima and Schwendiman 1970, Sutter et al. 1981, and Ammerich et al. 1989.

The release fraction/respirable fraction ($5.0 \times 10^{-4}/1.0$) is based on experimental data from burning of packaged, contaminated, mixed, combustible wastes as reported in Mishima and Schwendiman (1970). This value is also reported as the median release fraction/respirable fraction from the burning of contaminated, uncontained, combustible materials. The source term in Table 4-2 was developed by applying the following:

(curies) x (release fraction) x (respirable fraction).

4.3.1.2.2 Toxicological. The nitric acid storage vessel north of the 222-S Building is designed to hold up to 3,200 L (850 gal). Administrative control limits its capacity to 2,270 L (600 gal). The concrete berm around the tank is designed to contain the entire contents of the tank in the event of a leak, valve, or weld failure. The earthquake scenario provides an energy mechanism for creating the loss of nitric acid from the tank and the accompanying loss of structural integrity of the bermed containment. It is not considered credible that this magnitude earthquake would completely destroy the bermed containment, but it is considered credible that holes and cracks would occur. If the stainless steel tank is severed from the valved outlet and piping, the entire tank contents would drain. The berm is estimated to degrade above the stainless steel reinforcement sheets; 1,500 L (400 gal) is the estimated release to the asphalt surface (Table 4-3).

Table 4-3. Nitric Acid Source Term and Assumptions.

Volume	1,500 L (400 gal)
Area of spill	227 m^2 (2,445 ft^2)
Temperature	Liquid 27 °C (80 °F), Ambient 38 °C (100 °F)
Stability Class	F
Wind Speed	4.0 m/s

4.3.1.3 Consequences. Consequences have been calculated for the postulated earthquake approaching or exceeding 0.25g. These consequences have been compared with the appropriate criteria (refer to Section 4.5) and are presented in Tables 4-4 and 4-5.

Table 4-4. Dose Consequences for Bounding Worst-Case Accident.

Receptor	Consequences		Guidelines*	
	EDE (rem)	Organ (rem)	EDE (rem)	Organ (rem)
Onsite (900 m)	2.48	44 (bone surface)	≤5	≤50
Offsite (13.5 km)	0.056	1.0 (bone surface)	≤0.5	≤5

*Refer to Table 4-9.
EDE = effective dose equivalent.

Table 4-5. Exposure Consequences for Bounding Worst-Case Accident.

Receptor	Exposure (ppm)	Guidelines
Onsite (900.0 m)	3.7	ERPG-2 15 ppm
Offsite (13.5 km)	0.082	ERPG-1 2 ppm

1 ppm = 2.62 mg/m^3.
ERPG = Emergency Response Planning Guidelines (AIHA 1991).

4.4 PRELIMINARY HAZARDS ANALYSIS

The potential hazards in operating the 222-S Laboratory must be identified and evaluated. Once the hazards are identified, an evaluation of the frequency of occurrence, the amount of inventory, and the energies involved in releasing the hazardous material is performed. Further evaluation determines the potential consequences and associated risks.

Simple scenarios are developed for the mechanisms of release, accounting for mitigating factors. The PHA uses a systems modelling approach that describes the combination of safety functions and systems successes and failures that may lead to an accident and provides the sequence of events resulting in potential hazardous materials release. The risk associated with the amount of material released is evaluated with respect to specific facility operations, the potential exposures to other site workers and the general public, and the potential impacts to the environment. From this type of analysis, unique and representative accident scenarios are selected that adequately depict the range of potential accidents and also the range of potential risks. Refer to Table 4-6 for the PHA matrix.

An important element of the PHA is assigning relative probabilities to the occurrence of the initiating event and the subsequent release of hazardous materials. DOE-STD-1027-92 (DOE 1992) states that the probability assessment should be only qualitative for Category 3 facilities. This approach is used for this assessment (Tables 4-7 and 4-8).

Human error is often the limiting element in accident analyses. This is particularly true in a laboratory environment. Numerical values have been derived for certain human reliability coefficients. Operator error related to safety checks and operator failure to comply with established procedures are two probabilities that are easily referenced. These types of errors are anticipated to occur under normal operating conditions. The values and their references are as follows:

- Rates human error associated with operator failure to check equipment status at 1×10^{-3} where operator safety may be at stake; NUREG/CR-1278, *Handbook of Human Reliability Analysis, with Emphasis on Nuclear Power Plant Applications* (Swain and Guttman 1983)

- Rates human error of omission or commission following specific training at 1×10^{-2}; NUREG/CR-2300, *A Guide to the Performance of Probabilistic Risk Assessments for Nuclear Power Plants* (NRC 1983).

A greater than design basis accident analysis has been performed for the 222-S Laboratory (see Section 4.3). This analysis concluded that consequences associated with the operation of the 222-S Laboratory, based on the maximum inventory available for release and not taking credit for any mitigating measures, were acceptable. Thus, the mitigating features identified in the PHA are required to ensure safe operations and should not be perceived as Safety Class 1 or 2 systems or TSR derived administrative controls.

Table 4-6. Preliminary Hazards Analysis Matrix. (13 sheets)

System/ subsystem or building	Hazard or energy source	Potential accident sequence	Potential consequence and target	Mitigating features		Estimated probability level[a]	Estimated severity level[a]
				Engineered	Administrative		
Abnormal operations (natural phenomena/external events)							
222-S Laboratory	Seismic event (selected for further evaluation Section 4.6.1)	• Seismic event without structural damage to facility resulting in breech of laboratory chemicals/ radioactive samples (containers broken, shelving failure)	• Release of radioactive/toxic material within facility Facility worker: personnel injury/ exposure Environment: no impact Onsite: no impact Offsite: no impact	• Building integrity • Ventilation system	• Limit on quantities of radioactive material within facility	U	IV
	(Selected for further evaluation Section 4.3)	• Building collapse caused by earthquake-induced internal fire (physical damage to facility and containment systems--219-S, 207-SL, filter buildings, transfer lines, chemical storage vessels)	• Release of radioactive/toxic material to atmosphere/ground Facility worker: personnel injury/exposure/dose Environment: minor impact Onsite: minor receptor exposure/dose Offsite: minor receptor exposure/dose	• Building integrity • Fire protection and alarm system • Automatic wet pipe fire suppression system	• Limit on quantities of radioactive material within facility	EU	III
		• Loss/failure of power to ventilation system as a result of seismic event (loss of utilities)	• Radiological/toxicological exposure due to inadequate air balance control, potential backflow of contaminated air, unfiltered release; particulate release Facility worker: personnel exposure Environment: no impact Onsite: no impact Offsite: no impact	• Backflow prevention (damper) • Integrity of ventilation buildings and/or exhaust duct • Standby power • Redundant ventilation system	• Monitoring of air balance	EU	III

Table 4-6. Preliminary Hazards Analysis Matrix. (13 sheets)

System/ subsystem or building	Hazard or energy source	Potential accident sequence	Potential consequence and target	Mitigating features		Estimated probability level[a]	Estimated severity level[b]
				Engineered	Administrative		
		• Damage to the ^{252}Cf source and release of contamination into the shielding water as result of seismic event.	• Shielding water contamination Facility worker: potential exposure Environment: no impact Onsite: no impact Offsite: no impact	• DOT-approved container • Radiation alarm • Shielding concrete pit integrity	• Pit monitoring by HPTs	EU	IV
	Volcanic/ashfall	• Physical damage to facility and confinement systems	• Release of radioactive/toxic material to atmosphere Facility worker: personnel injury/exposure Environment: no impact Onsite: no impact Offsite: no impact	• Building integrity, roof loading criteria	• Facility evacuation • Facility shutdown	EU	III
		• Loss/failure of ventilation system caused by ash plugging intake filters	• Localized radiological/toxicological exposure due to inadequate air balance control Facility worker: personnel exposure Environment: no impact Onsite: no impact Offsite: no impact	• Low intake alarm	• Facility evacuation • Facility shutdown	U	III
	High winds/ tornado	• Major structural damage to facility as a result of high winds	• Release of radioactive/toxic material to atmosphere Facility worker: personnel injury/exposure Environment: no impact Onsite: no impact Offsite: no impact	• Building integrity • Filtered exhaust system	• Facility evacuation • Facility shutdown	EU	III

Table 4-6. Preliminary Hazards Analysis Matrix. (13 sheets)

System/ subsystem or building	Hazard or energy source	Potential accident sequence	Potential consequence and target	Mitigating features		Estimated probability level[a]	Estimated severity level[b]
				Engineered	Administrative		
		• Wind/tornado driven missile strikes building and equipment causing loss of utilities	• Localized radiological/toxicological exposure due to inadequate air balance control Facility worker: personnel injury/exposure Environment: no impact Onsite: no impact Offsite: no impact	• Backflow damper	• Monitoring of air balance	U	III
	Flood	• Flood causes building damage and contamination spread	• Contamination spread within facility Facility worker: personnel injury/exposure Environment: contamination Onsite: no impact Offsite: no impact	• Facility not located in floodplain area		I	III
	Range fire	• Range fire causes ignition of the 222-S Building and surrounding facilities	• Release of radioactive/toxic material Facility worker: personnel injury/exposure Environment: minor impact Onsite: minor impact Offsite: no impact	• Fire suppression system • Noncombustible structure • Hanford Fire Department	• Limit on quantities of radioactive material within facility • Emergency response	EU	III

Table 4-6. Preliminary Hazards Analysis Matrix. (13 sheets)

System/ subsystem or building	Hazard or energy source	Potential accident sequence	Potential consequence and target	Mitigating features		Estimated probability level[a]	Estimated severity level[a]
				Engineered	Administrative		
Abnormal operations (accidents)							
222-S Building	Radioactive material (selected for further evaluation Section 4.6.2.1)	• Radioactive material sample is dropped during loading and unloading transfer cask/pig or core sample cask (100-ml sample)	• Release of radioactive material to environment/facility Facility worker: personnel injury/exposure Environment: no impact Onsite: no impact Offsite: no impact	• Cask/pig integrity • Liner integrity • Sample carrier	• SARP (dose limits) • Training • Procedures	A	III
	Radioactive material	• Higher than normal radiation level core sample cask or pig sample is received (improperly packaged and shipped sample)	• Personnel exposed to high radiation levels during transfer from cask to hot cell Facility worker: personnel exposure Environment: no impact Onsite: no impact Offsite: no impact	• Cask to hot cell mating feature • Cask/pig integrity • Overpack (pig) integrity	• Sample receiving procedure • Training • SARP limits • HPT survey (smear and dose rate)	A	III
	Radioactive/ toxic/flammable	• Ignition of flammables and combustibles in hot cell (fire in hot cell) causing the filters to become loaded and over-pressurization of hot cell not resulting in breech of hot cell	• Release of radioactive/toxic material within facility ventilation system or possibly atmosphere Facility worker: no impact Environment: no impact Onsite: no impact Offsite: no impact	• Ventilation system (prevents stagnation of vapors) • Wet pipe fire suppression system within 1E hot cell • Upstream HEPA filtration (SC, SB)	• Operating procedures limiting combustible materials in hot cells • Inspection/ surveillance	EU	IV

Table 4-6. Preliminary Hazards Analysis Matrix. (13 sheets)

System/ subsystem or building	Hazard or energy source	Potential accident sequence	Potential consequence and target	Mitigating features		Estimated probability level[a]	Estimated severity level[b]
				Engineered	Administrative		
	Radioactive/toxic material	• Metal rod for extruding samples with hydraulic press becomes propelled under pressure causing failure of hot cell viewing window	• Release of radioactive/toxic material within facility Facility worker: personnel injury/exposure Environment: no impact Onsite: no impact Offsite: no impact	• Deflector • Hot cell (window) integrity • Ventilation system	• Operating procedures	I	III
	Radioactive material	• Solid/liquid sample dropped in hot cell	• Release of dust/vapors within hot cell Facility worker: none Environment: no impact Onsite: no impact Offsite: no impact	• Upstream HEPA filtration • Sample holders	• Operator training	A	IV
	Radioactive/ toxic/flammable (selected for further evaluation Section 4.6.3)	• Fire/explosion caused by loss of (power) exhaust system and the ignition of stagnant gas in fume hoods • Obstructed individual hood HEPA filter causes stagnation of gas then fire/explosion with possible HEPA fire	• Release of radioactive/toxic material within facility or ventilation system or possibly atmosphere Facility worker: personnel injury/ exposure Environment: no impact Onsite: no impact Offsite: no impact	• Ventilation system (prevents stagnation of vapors) • Wet pipe fire suppression system within laboratory area • Upstream HEPA filtration (SB) • Standby power	• Operating procedures • Hood flow velocity (monthly)	EU	III

Table 4-6. Preliminary Hazards Analysis Matrix. (13 sheets)

System/ subsystem or building	Hazard or energy source	Potential accident sequence	Potential consequence and target	Mitigating features		Estimated probability level[a]	Estimated severity level[a]
				Engineered	Administrative		
	Radioactive/ volatile toxic chemicals	• Sample container dropped and broken, tipped over, or damaged during handling; reaction caused by improper storage/mixing of chemicals	• Release of toxic material within facility Facility worker: personnel injury/exposure Environment: no impact Onsite: no impact Offsite: no impact	• Shelf storage design • Transport cart design • Unbreakable sample container • Filtered ventilation exhaust system	• Laboratory sample handling procedures • Limit on quantities being handled	A	III
	Radioactive/toxic material (selected for further evaluation Section 4.6.5)	• Out-of-control vehicle (truck, car, construction equipment) impacts facility or exhaust duct and causes loss of confinement	• Release of radioactive material Facility worker: personnel exposure Environment: minor impact Onsite: no impact Offsite: no impact	• Signs/warnings • Ventilation system • Concrete berm and stop posts around nitric acid tank	• Training • Procedures • Speed limit	U	III
	Low-level radioactive solid waste (boneyard)	• Fire induced by ignition of surrounding vegetation and plywood containers	• Release of radioactive material Facility worker: personnel injury/exposure Environment: minor ground contamination Onsite: minor impact Offsite: no impact	• Fire retardant liners and containers • Hanford Fire Department	• Limited to Type A quantities of radioactive material	EU	III

Table 4-6. Preliminary Hazards Analysis Matrix. (13 sheets)

System/ subsystem or building	Hazard or energy source	Potential accident sequence	Potential consequence and target	Mitigating features		Estimated probability level[a]	Estimated severity level[b]
				Engineered	Administrative		
	Low-level radioactive/ chemical liquid/ solid waste (TSD) (selected for further evaluation Section 4.6.5)	• Out-of-control vehicle (truck, car) impacts storage boxes, causing fire and release of material stored	• Release of radioactive/chemical material to atmosphere Facility worker: personnel injury/exposure Environment: minor ground contamination Onsite: minor impact Offsite: no impact	• Fire retardant liners and containers • Connex box integrity • Hanford Fire Department	• Limited to Type A quantities of radioactive material	EU	III
	Low-level radioactive/ chemical liquid/ solid waste (TSD)	• Breech of containers in steel storage boxes caused by high temperatures, corrosion, drop of container	• Release of radioactive/toxic material to atmosphere Facility worker: personnel injury/ exposure Environment: no impact Onsite: no impact Offsite: no impact	• Drum/box integrity	• Limited to Type A quantities of radioactive material	U	III
	Toxic material (selected for further evaluation Section 4.6.5)	• Out-of-control vehicle (truck, car) impacts 3,200-L (850-gal) nitric acid tank located outside of facility	• Release of toxic material to atmosphere Facility worker: injury/exposure Environment: minor impact Onsite: minor impact Offsite: no impact	• Tank integrity • Berm integrity • Stop posts	• Posted speed limit	U	III
	Toxic material	• Inadvertent spill of 760-L (200-gal) nitric acid tank when refilling within facility, room S1A	• Release of toxic material within facility/207-SL basins Facility worker: injury/exposure Environment: no impact Onsite: no impact Offsite: no impact	• Drain pan to 219-S	• Training • Sample procedures	A	III

Table 4-6. Preliminary Hazards Analysis Matrix. (13 sheets)

System/ subsystem or building	Hazard or energy source	Potential accident sequence	Potential consequence and target	Mitigating features		Estimated probability level[a]	Estimated severity level[b]
				Engineered	Administrative		
	Explosive/ flammable	• Pressurized gas cylinder is dropped while being fitted	• Structural damage caused by missile Facility worker: personnel injury/exposure Environment: no impact Onsite: no impact Offsite: no impact	• Cylinder cradle • Valve cover	• Gas cylinder handling/fitting procedures	EU	III
222-SA Standards Laboratory	Toxic material (acids/bases/ organics/volatile toxic chemicals; selected for further evaluation Section 4.6.2)	• Spill of laboratory chemical ; overpressurization due to high temperature; improper mixture of chemicals causing reaction (4-L containers)	• Release of toxic material Facility worker: injury/exposure Environment: no impact Onsite: no impact Offsite: no impact	• Shelf storage design • Transport cart design	• Laboratory sample handling procedures	U	III
	Explosive/ flammable	• Pressurized gas cylinder is dropped while being fitted	• Structural damage caused by missile Facility worker: personnel injury/exposure Environment: no impact Onsite: no impact Offsite: no impact	• Cylinder cradle • Valve cover	• Gas cylinder handling/fitting procedures	EU	III
	Toxic/flammable	• Fire/explosion caused by loss of (power) exhaust system and the ignition of stagnant gas or the mixture of incompatible materials in fume hoods	• Release of toxic material within facility or ventilation system or possibly to atmosphere Facility worker: personnel injury/exposure Environment: no impact Onsite: no impact Offsite: no impact	• Ventilation system (prevents stagnation of vapors) • Wet pipe fire suppression system within laboratory area	• Operating procedures • Differential pressure readings (monthly)	U	III

Table 4-6. Preliminary Hazards Analysis Matrix. (13 sheets)

System/ subsystem or building	Hazard or energy source	Potential accident sequence	Potential consequence and target	Mitigating features		Estimated probability level[a]	Estimated severity level[b]
				Engineered	Administrative		
2716-S Laboratory chemical/ equipment Storage	Toxic material (acids/bases/ organics) (selected for further evaluation Section 4.6.2)	• Spill of laboratory chemical; over pressurization due to high temperature; inadvertent mixture of chemicals within facility	• Release of toxic material Facility worker: injury/exposure Environment: no impact Onsite: no impact Offsite: no impact	• Temperature indicators • Heating/cooling	• Training • Procedures	A	III
	Toxic material (acids/bases/ organics)	• Inadvertent spill of chemicals from cart during transfer to laboratory	• Release of toxic material to ground/ atmosphere (6 to 8 L) Facility worker: injury/exposure Environment: no impact Onsite: no impact Offsite: no impact	• Cart design	• Training • Procedures	A	III
219-S Waste Handling Facility	Liquid radio-active material	• Breech of containment caused by overflow, excessive heat/corrosion	• Radioactive liquid release to ground Facility worker: no impact Environment: minor ground contamination Onsite: no impact Offsite: no impact	• Tank integrity • Tank level indicators • Temperature indicators • Sump/alarms overflow	• Training • Procedures • Inspection/ surveillance	U	III
	Liquid radioactive material	• Mixture of incompatible materials causes energetic reaction	• Accelerated release of radioactive or toxic material Facility worker: exposure Environment: minor impact Onsite: minor impact Offsite: no impact	• Temperature alarms/ indicators • HEPA filter system • tank integrity	• Training • Procedures • Inspection/ surveillance	U	III

Table 4-6. Preliminary Hazards Analysis Matrix. (13 sheets)

System/ subsystem or building	Hazard or energy source	Potential accident sequence	Potential consequence and target	Mitigating features		Estimated probability level[a]	Estimated severity level[b]
				Engineered	Administrative		
	Liquid radioactive material	• Spray leak resulting from a transfer piping failure during transfer operations from tank to truck	• Release of radioactive material to atmosphere Facility worker: exposure Environment: ground contamination Onsite: no impact Offsite: no impact	• Piping integrity	• Inspection/ surveillance • Procedures	U	III
	Liquid radioactive material	• Demister fails causing HEPA filter to become wet causing unfiltered release	• Release of radioactive material to atmosphere Facility worker: exposure Environment: no impact Onsite: no impact Offsite: no impact	• Differential pressure gages • High pressure alarm	• Air samples	EU	III
	Liquid radioactive material	• Mistransfer to D-Cell 202-S or to 102-SY tank farms (unauthorized transfer)	• Material incompatibilities, spray release Facility worker: exposure Environment: no impact Onsite: no impact Offsite: no impact	• Concrete encased piping	• Inspection/ surveillance • Training • Procedures	A	IV
	Toxic material (sodium hydroxide)	• Out-of-control vehicle impacts 219-S Facility causing failure of 2,650-L (700-gal) sodium hydroxide tank (liquid)	• Release of toxic material to ground Facility worker: injury/exposure Environment: ground contamination Onsite: no impact Offsite: no impact	• Building integrity • Tank integrity	• Training procedures	U	III

Table 4-6. Preliminary Hazards Analysis Matrix. (13 sheets)

System/ subsystem or building	Hazard or energy source	Potential accident sequence	Potential consequence and target	Mitigating features		Estimated probability level[a]	Estimated severity level[b]
				Engineered	Administrative		
	Liquid radioactive/ toxic material (selected for further evaluation Section 4.6.4)	• Accidental drop of 4,080-kg (9,000-lb) cover block during installation or removal causing breech of tank/pipe containments	• Release of radioactive/toxic material Facility worker: injury/exposure Environment: ground contamination Onsite: minor impact Offsite: no impact	• Tank/piping integrity • Vault integrity	• Hoisting/ rigging procedures	U	III
207-SL Retention basins	Liquid radioactive/toxic material	• Failure of basins or tanks (breech of containment)	• Release of radioactive/toxic material to ground Facility worker: minor exposure Environment: minor ground contamination Onsite: no impact Offsite: no impact	• Basin integrity • Level indicators	• Surveillance • Procedures	EU	III
	Liquid radioactive/toxic material	• Inadvertent release of highly radioactive/toxic material to basins (1 L)	• Basin contaminated with higher levels of radiation Facility worker: exposure Environment: no impact Onsite: no impact Offsite: no impact	• Basin sampled before transfer	• Inspection/ surveillance • Training	U	III
	Liquid radioactive/toxic material	• Inadvertent misroute to crib 216-S-20	• Release to crib Facility worker: no impact Environment: minor ground contamination Onsite: no impact Offsite: no impact	• Line is out of service	• Procedures/ training	EU	IV

Table 4-6. Preliminary Hazards Analysis Matrix. (13 sheets)

System/ subsystem or building	Hazard or energy source	Potential accident sequence	Potential consequence and target	Mitigating features		Estimated probability level[a]	Estimated severity level[a]
				Engineered	Administrative		
222-SD Solid Waste Handling/ Storage System	Radioactive material (selected for further evaluation Section 4.6.5)	• Vehicle impact causes damage of storage facility; fire and drum rupture	• Release of drum contents to atmosphere Facility worker: injury/exposure Environment: no impact Onsite: no impact Offsite: no impact	• Building integrity • Drum integrity	• Type A quantities • Posted speed limit	U	III
	Radioactive material	• Drum is dropped during transfer and contents of drum are expelled	• Release of drum contents to atmosphere Facility worker: injury/exposure Environment: no impact Onsite: no impact Offsite: no impact	• Drum integrity	• Training/ procedures (hoisting and rigging)	A	III
212-S and 213-S Gas storage docks	Explosive/ flammable	• Pressurized gas cylinder is dropped during handling	• Results in no release Facility worker: injury Environment: no impact Onsite: no impact Offsite: no impact	• Gas cylinder integrity	• Gas cylinder handling procedures	A	IV
	Explosive/ flammable	• Leak of flammable gas from cylinder	• Release of toxic material Facility worker: injury Environment: no impact Onsite: no impact Offsite: no impact	• None	• Gas cylinder handling procedures	U	IV

Table 4-6. Preliminary Hazards Analysis Matrix. (13 sheets)

System/ subsystem or building	Hazard or energy source	Potential accident sequence	Potential consequence and target	Mitigating features		Estimated probability level[a]	Estimated severity level[b]
				Engineered	Administrative		
Filter buildings (222-SC, 222-SE, 222-SB)	Low-level radioactive particulate	• Inadvertent drop of HEPA filter	• Release of radioactive material within building Facility worker: exposure Environment: no impact Onsite: no impact Offsite: no impact	• Building confinement (222-SC) • 222-SB vent system • Protective clothing	• Handling procedures • Filter loading criteria	A	III
	Low-level radioactive material (selected for further evaluation Section 4.6.5)	• Out-of-control vehicle (truck, car, construction equipment) impacts filter buildings and causes fire	• Release of radioactive material Facility worker: injury/exposure Environment: minor impact Onsite: receptor receives dose Offsite: no impact	• Building integrity	• Training • Procedures • Signs/warnings	U	III

[a]Estimated frequency ranges:

A	= Anticipated (10^{-2} to 1).
U	= Unlikely (10^{-4} to 10^{-2}).
EU	= Extremely unlikely (10^{-6} to 10^{-4}).
I	= Incredible ($< 10^{-6}$).

[b]Estimated accident severity levels (see Table 4-8):

I	= Major offsite/environment consequence
II	= Minor offsite/environment consequence, major onsite
III	= Minor onsite/environment consequence, major facility worker
IV	= No onsite or offsite consequence or significant impact on environment, no significant impact to facility worker.
DOT	= U.S. Department of Transportation.
HEPA	= high-efficiency particulate air (filter).
HPT	= health physics technician.
SARP	= safety analysis report for packaging.
TSD	= temporary storage and disposal (area).

Table 4-7. Probability Category Definition.

Probability category	Category definition	Nominal range of annual probability
Anticipated	An off-normal condition that individually may be expected to occur once or more during the plant lifetime.	10^{-2} to 10^{-1}
Unlikely	Individually, the condition is not expected to occur during plant lifetime, but collectively, events in this category may occur several times.	10^{-4} to 10^{-2}
Extremely unlikely	Extremely low probability conditions that are not expected during the plant lifetime but that represent extreme or limiting cases of faults identified as possible. This category includes design basis accidents.	10^{-6} to 10^{-4}
Incredible	Accidents for which no credible scenario can be identified.	$<10^{-6}$

Table 4-8. Qualitative Accident Severity Levels.

Severity categories	Consequence to the public, workers, or environment
Category I	May cause deaths onsite or loss of the facility/ operation, major injuries or illness offsite, radiation exposure to offsite individuals in excess of annual limits, or severe impact on the environment
Category II	May cause severe injuries or severe occupational illness onsite, exposure to onsite individuals in excess of annual limits, major damage to a facility/ operation, minor illness or injury offsite, exposure to offsite individuals to radiation below annual limits, or major impact on the environment
Category III	May cause minor injury or minor occupational illness onsite, or exposure of onsite individuals to radiation below annual limits, negligible impact offsite, or minor impact on the environment
Category IV	Will not result in injury, occupational illness, or exposure onsite or offsite or result in a significant impact on the environment

4.5 RADIOLOGICAL AND NONRADIOLOGICAL RISK ACCEPTANCE GUIDELINES

Using potential radiological and toxicological consequences associated with the accidents analyzed and a qualitative estimate of the frequency category (provided in the PHA) a comparison with the radiological and toxicological risk acceptance guidelines provided in WHC-CM-4-46 was performed. These guidelines are shown in Tables 4-9 and 4-10. Although the estimated frequency categories for the hazards identified in the PHA have been given in Table 4-6, for conservatism, calculated consequences associated with the selected accidents have been evaluated against the most limited (i.e., exposure) consequence guidelines, which are defined as frequency category anticipated.

Table 4-9. Radiological Risk Acceptance Guidelines.*

Frequency category	Frequency range	Effective dose equivalent (rem)	Organ dose equivalent for lens of eye (rem)	Organ dose equivalent for all other organs (rem)
Offsite guidelines				
Anticipated	1.0 to 10^{-2}	0.01 to 0.5	0.03 to 1.5	0.1 to 5
Unlikely	10^{-2} to 10^{-4}	0.5 to 4	1.5 to 12	5 to 40
Extremely unlikely	10^{-4} to 10^{-6}	4 to 25	12 to 75	40 to 250
Onsite guidelines				
Anticipated	1.0 to 10^{-2}	1 to 5	3 to 15	10 to 50
Unlikely	10^{-2} to 10^{-4}	5 to 25	15 to 75	50 to 250
Extremely unlikely	10^{-4} to 10^{-6}	25 to 100	75 to 300	250 to 1000

*Taken from WHC-CM-4-46.

Table 4-10. Nonradiological Risk Acceptance Guidelines.*

Frequency	Concentration	
	Onsite	Offsite
1 to 10^{-6}	ERPG-2 to ERPG-3	ERPG-1 to ERPG-2

*Taken from WHC-CM-4-46
ERPG = Emergency Response Planning Guidelines (AIHA 1991).

4.6 PRELIMINARY HAZARDS ANALYSIS BASED ACCIDENTS

This section attempts to bound the perceived accidents by potential consequence as they relate to the release mechanism. The PHA provides an implicit basis for selecting a unique accident or the representative accidents from the relative frequency of occurrence and the relative risk. This does not imply that all abnormal conditions and accidents capable of worker exposure or injury or environmental contamination are covered, but that the limiting accident by source-term release and consequence are addressed. Other accidents of less consequence are anticipated but not rigorously analyzed (PHA). Analysis of dose and exposure to the general public are not evaluated here. (By definition, a Category 3 facility has only significant local effects. The hazards categorization and the beyond-design-basis accident (Section 4.3) both support the Category 3 designation. Additionally,the 222-S Laboratory is located far enough from public access that consequences to the general public are not bounding by virtue of negligible projected dose or exposure.

4.6.1 Earthquake, 0.12g

Earthquakes of lesser magnitude than the worst-case bounding accident are expected to occur at a slightly greater frequency (4×10^{-4}) than the 0.25g earthquake. The effects of this magnitude earthquake should be localized doses, exposures, and contaminations contained within the individual facilities and would be bounded within the envelope of accidents and consequences described in Section 4.6. Plausible sequences of events and release mechanisms are described throughout Section 4.6. This accident should be considered the design basis accident and could affect any of the facilities in the 222-S Laboratory equally.

4.6.1.1 Accident Scenario. An earthquake approaching or exceeding 0.12g is postulated to occur on the 200 Area plateau. Personnel in the 222-S Laboratory feel the earth tremble. Glass windows break, and unsecured containers rattle and vibrate off tables, carts, and laboratory benches. The utilities are designed to withstand this magnitude ground movement and remain operational (refer to Chapter 3.0).

4.6.1.2 Source Term. The source term is limited to laboratory quantity reagents and diluted waste samples awaiting analysis. Although multiple spills of like substances may occur in a number of different laboratories, the consequences remain localized and the source term is not effectively increased because of engineered design features (e.g., zoned concept ventilation and increasing negative air balance). Refer to the accidents described in Section 4.6.2 for a more detailed description of the source term and the projected consequences.

4.6.2 Spills

Spills involving radioactive samples or toxic laboratory chemical reagents, or both, are anticipated events (i.e., 1.0 to 1.0×10^{-2}/yr). The consequences of such events are dependent upon the material activity or toxicity and the environment. The amounts of material spilled are limited to operational laboratory quantities and sample activity. Therefore, no out-of-facilities consequences are anticipated.

Many chemicals are used in analytic laboratory operations. They range from highly toxic substances to those that are essentially inert and benign. The volumes encountered in day-to-day operations are small in comparison to reporting requirements (40 CFR 302.4). The toxic effects of these chemicals are broad. An evaluation of the potential hazards is made based on the following: route of entry, vapor pressure, permissible exposure limits, immediately dangerous to life or health (IDLH), carcinogenicity, and inventory. Because there is no absolute method to evaluate which substance (of the thousands) could create the greatest potential harm to a facility employee, this approach provides a screening mechanism. The chemicals are selected using "best safety and health" judgement but are representative of the acute chemical exposure hazards. (Chemical incompatibilities [e.g., phosgene, cyanides, acid mists] were considered [Table 4-6] but omitted from detailed consideration based on estimated probability and consequence levels. The release of 1,500 L [400 gal] of nitric acid [Section 4.3] was considered a bounding event.) Specific emergency planning and response must be evaluated and implemented, if necessary, when inventories meet or exceed threshold planning quantities. Table 4-11 illustrates the relatively low quantities of these materials kept in inventory and that the projected exposures to onsite personnel and the public are extremely low. Exposures to potentially harmful levels of these and other substances are limited to facility personnel.

Typical radionuclide constituents from the waste tanks include a variety of fission products and actinides. The primary constituents and dose contributors from waste tank samples are ^{90}Sr and ^{137}Cs. The ^{239}Pu sample analyses are purposefully limited to retain the facility designation as isolated facility, thereby effectively limiting the ^{239}Pu inventory administratively below 11 Ci; i.e., one-third critical mass. A typical range of radionuclides included in each sample received for analysis at the 222-S Laboratory is given in Table 4-12.

4.6.2.1 Radiological Spill Scenario. A 100-ml polyethylene bottle containing a slurried sample from waste tank 241-AZ-101 is received at sample logging. During the transfer of the sample into hot cell 1E-1, the shielding pig containing the sample is dropped. The sample container falls onto the asphalt or tile floor, exposing facility personnel to the unshielded sample. It is assumed that the sample container does not fail; however, should the container fail, inhalation dose would be insignificant based on worker training and response action (e.g., immediate evacuation of area). The consequences associated with this type of accident should be limited to the 222-S Building.

4.6.2.1.1 Source Term. The highest activity samples, excluding special samples that may arrive from the B Plant or the Waste Encapsulation and Storage Facility, would be expected from waste tank 241-AZ-101, the sole remaining aging waste tank in the Hanford Site Tank Farms. The most recent available analysis of tank 241-AZ-101 is from April 1989, and is referenced in PNL 9004632, *Characterization of the Second Core Sample of Neutralized Current Acid Waste from Double Shell Tank AZ-101* (PNL 1990). The concentrations have not been decay corrected. The results indicate the following concentrations and total activity per radionuclide in a 100-ml bottle (Table 4-13):

- Density: 1.70 g/ml
- Sample mass: 170 g.

The geometry and density of the spill are vital input parameters for exposure modelling. The modelling tool for evaluating the exposure rate generated by the postulated spill is MICROSHIELD by Grove Engineering. (Because all samples are either liquids, wetted solids, or both, and

Table 4-11. Extremely Hazardous Substances.

Substance	Amount (lb)	OSHA PEL (ppm)	RQ[a] (lb)	TPQ (lb)
Aniline	6.1	2	5,000	1,000
Cadmium oxide	1.1	5 mg/m^3	1	100
Carbon disulfide	1.39	4	100	10,000
Chloroform	41.29	2	10	10,000
Hydrazine	4.41	0.1	1	1,000
Hydrofluoric acid	1.0	3	100	100
Nitric acid[b]	52.58	2	1,000	1,000
Nitrobenzene	3.98	1	1,000	10,000
Mercuric chloride	1.38	0.1 mg/m^3	1	500
Phenol	2.2	5	1,000	500
Phenylmercury acetate	0.22	0.5	100	500
Potassium cyanide	4.52	5 mg/m^3	10	100
Pyrene	0.11	n/a	5,000	1,000
Sodium arsenate	0.22	n/a	1	1,000
Sodium azide	0.44	0.1 C	1,000	500
Sodium cyanide	0.22	5 mg/m^3	10	100
Sodium selenate	0.66	0.2 mg/m^3	100	100
Sulfuric acid	24.26	1	1,000	1,000
Tellurium	0.36	0.1 mg/m^3	1	500

[a]Indicates statutory or final reportable quantity.
[b]Does not include bulk storage amounts.
n/a = No OSHA (or ACGIH TLV) value listed.
ACGIH = American Conference of Governmental Industrial Hygienists.
C = OSHA Ceiling value.
OSHA = Occupational Safety and Health Administration.
PEL = permissible exposure limits (OSHA).
RQ = reportable quantities.
TPQ = threshold planning quantities.
TLV = threshold limit values.

Table 4-12. Representative Radionuclides.

Isotope	Isotope	Isotope	Isotope
^{3}H	^{103m}Ru	^{129}I	^{234}U
^{14}C	^{106}Ru	^{134}Cs	^{235}U
^{55}Fe	^{106}Rh	^{135}Cs	^{238}U
^{60}Co	^{110m}Ag	^{137}Cs	^{237}Np
^{89}Sr	^{110}Ag	^{137m}Ba	^{238}Pu
^{90}Sr	^{113m}Cd	^{141}Ce	^{239}Pu
^{90}Y	^{125}Sb	^{144}Ce	^{240}Pu
^{91}Y	^{125m}Te	^{144}Pr	^{241}Pu
^{93}Zr	^{126}Sn	^{147}Pm	^{241}Am
^{93m}Nb	^{126m}Sb	^{148m}Pm	^{242m}Am
^{95}Zr	^{127}Te	^{148}Pm	^{242}Am
^{95m}Nb	^{127m}Te	^{151}Sm	^{243}Am
^{95}Nb	^{129m}Te	^{152}Eu	^{239}Np
^{99}Tc	^{129}Te	^{154}Eu	^{242}Cm
^{103}Ru	--	--	^{244}Cm

laboratory procedure requires the expedient "fixation" of contamination, inhalation is not considered a route of potential exposure.) This type of spill may occur inside or outside of the 222-S Building and over an asphalt,concrete, or tiled surface. The recommended geometry is an end cylinder with areas of 0.077 m^2 at a 0.0013-m depth and 0.026 m^2 at a 0.0038-m depth for the smooth and rough surface spill, respectively. The recommended source density is that of the sample, 1.7 g/ml, and the source density determined from a 50:50 mixture of water and concrete (concrete approximating the density of the sample solids).

4.6.2.1.2 Consequences. Microshield results returned the value of 240 mR/h at 0.61 m (2 ft). The resultant exposure to personnel should be considerably less. Contamination fixation should be immediate, and it is not conceivable that personnel would remain in close proximity for more than 1 hour under worst-case conditions.

4.6.2.2 Inorganic Spill Scenario. Fuming nitric acid is used to concentrate samples at various stages of sample preparation before analysis. It is stored in glass, 1-L containers at the 2716-S Storage Building in that portion of the building partitioned for acid and base storage. Occasionally personnel are

Table 4-13. Tank AZ-101 Sample.

Radionuclide	Concentration (µCi/g)	Sample activity (µCi)
^{3}H	1.50 E-02	2.55 E+00
^{14}C	1.90 E-03	3.23 E-01
^{60}Co	1.20 E+01	2.04 E+03
^{90}Sr	2.40 E+04	4.08 E+06
^{99}Tc	8.10 E-01	1.38 E+02
^{129}I	<6.50 E-04	<1.11 E-01
^{137}Cs	1.70 E+03	2.89 E+05
^{154}Eu	8.20 E+01	1.39 E+04
Uranium	2.85 E-05[a] (mmol/g)	1.15 E-03[b] (g)
^{238}Pu	6.90 E-01	1.17 E+02
^{239}Pu	3.40 E+00	5.78 E+02
$^{239/240}Pu$	4.40 E-01	7.48 E+01
^{241}Am	5.90 E+01	1.00 E+04

[a]Uranium concentration is in mmol/g.
[b]Uranium sample activity is in grams.

required to transfer fuming nitric acid from supply stock in the 2716-S Storage Building. While transferring the 1-L glass container from the storage shelf, the container is dropped and its contents spill onto the cement floor.

4.6.2.2.1 Source Term. This scenario depicts the spill of 1 L of fuming nitric acid. Considerations in determining potential exposure are listed in Table 4-14.

4.6.2.2.2 Consequences. This type of spill could have a potentially serious impact to the worker. Spilled material could contact nonprotected skin and clothing and cause serious burns because of the material's high corrosivity. However, the very acrid odor and realization of inhalation danger should quickly alert the worker to leave the facility. The impacts are negligible provided immediate egress occurs and the material does not contact unprotected skin and clothing.

Table 4-14. Inorganic Spill Source Term.

Volume of room	45,280 L (1,600 ft^3 or 1,852 moles)
Volume of spill	1 L (23.8 moles, Sp.g. 1.5, mwt. 63)
Temperature of air and nitric acid	20 °C (≈70 °F)
Vapor pressure	48 mmHg
Equilibrium concentration (closed environment)	63,000 ppm
Maximum possible concentration (closed environment)	12,850 ppm
OSHA PEL	2 ppm
OSHA STEL	4 ppm
NIOSH IDLH	100 ppm
AIHA ERPG-1*	2 ppm
AIHA ERPG-2*	15 ppm
AIHA ERPG-3*	30 ppm

*AIHA ERPG value are draft only.
AIHA = American Industrial Hygiene Association.
ERPG = Emergency Response Planning Guidelines.
NIOSH = National Institute for Occupational Safety and Health.
OSHA = Occupational Safety and Health Administration.
PEL = permissible exposure limit.
STEL = short-term exposure limit.

The potential environmental exposures are ≈0.07% (23.8/32, 450) of the worst-case accident described in Section 4.3 based on total moles available for release. Additional consideration could be given to the initial release rate, because of the 16 times higher vapor pressure, but the spill size (and therefore relative source term) would be much less than that for the nitric acid storage tank accident, again indicating much less potential exposure.

4.6.2.3 Organic Spill Scenario. The organic chemical inventory is very large; however, only chloroform is present in total inventory exceeding the reportable quantity (40 CFR 302.4) and also designated as an extremely hazardous substance (40 CFR 355, Appendix A). A total of 12.5 L of chloroform may be in inventory at any one time, but the common container size for bulk reagents would be 1 L.

A 1-L glass container of chloroform is commonly stored in individual laboratories. A laboratory worker needs to use chloroform in a sample preparation step. The worker goes to the storage closet to get the reagent. With the chloroform in hand, the worker proceeds back to the hood. En route, the worker slips on some loose debris and flings the container in an attempt to remain balanced. The container hits the floor, breaks, and releases its entire contents.

4.6.2.3.1 Source Term. Considerations in determining potential exposure are listed in Table 4-15.

Table 4-15. Organic Spill Source Term.

Volume of laboratory	56,650 L (2,000 ft^2 or 2,315 moles)
Volume of spill	1 L (12 moles, Sp.g. 1.48, mwt. 123.6)
Temperature	20 °C (≈70 °F)
Vapor pressure	160 mm Hg
Equilibrium concentration (closed environment)	210,000 ppm
Maximum possible concentration (closed environment)	5,200 ppm
OSHA PEL	2 ppm
NIOSH STEL (60 minutes)	2 ppm
NIOSH IDLH	1,000 ppm
3 x PEL*	6 ppm
5 x PEL*	10 ppm
NAS EEGL*	100 ppm

*Recommended values for ERPGs when unavailable from the AIHA.
EEGL = emergency exposure guidance level
IDLH = immediately dangerous to life or health.
NAS = National Academy of Sciences
NIOSH = National Institute of Safety and Health.
OSHA = Occupational Safety and Health Administration.
PEL = permissible exposure limit.
STEL = short-term exposure limit.

4.6.2.3.2 **Consequences.** The maximum possible exposure is 5,200 ppm in a closed environment; however, acute toxicity begins at 30 minutes or longer to exposures of 1,000 ppm or more. The vapor pressure is relatively high at 160 mmHg at 20 °C, and evaporation would be relatively rapid for a large surface area spill.

The following parameters are considered in assessing the potential exposure and risks: approximately seven room air changes per hour; the conservative estimate of the individual laboratory size; and the time of exposure (IDLH is evaluated for 30-minute exposures). This simple evaluation shows that, without worker injury, prolonged exposures will not occur. This is indicative of minimal risk. However, it is important to execute ALARA principles for exposures to any carcinogen.

Chloroform has a "sweet, pleasant" odor that would be noticeable to a worker. If an equal magnitude spill occurs in the corridor outside of a laboratory, the odor alerts incidental personal, and the larger volume of air provides greater dilution and lessens the potential exposure.

4.6.3 Fire

During routine operations, fires would be isolated events limited to bench tops or single laboratories. However, if a fire or an explosion occurs in a hot cell or in a laboratory hood serviced by flammable gas (or using/storing flammable solvents), the primary HEPA filter may be breached. This could allow either burning gases or burning combustible material to be transported through the ventilation ducts to the filter houses where the HEPA filters could ignite, releasing radiological materials into the atmosphere.

This may occur in the 222-SB, 222-SC, or 222-SE Filter Buildings. (The 222-SB has a metal mesh screen fire trap, which should prevent flammable debris from reaching the HEPA banks.) Another initiator could be a vehicle crashing through the filter buildings and subsequent ignition of the HEPA filter banks, releasing accumulated radioactive material into the environment.

4.6.3.1 Accident Scenario. Frequent vehicle and pedestrian traffic exists between 202-S and the 222-S Building. It is plausible that a truck travelling faster than recommended could attempt to avoid a pedestrian and slam into the 222-SC Filter House. The truck can break through the walls, leak gasoline from a torn gas line or ruptured gas tank, and spread gasoline about and into the premises. Ignition may result from hot contact surfaces or a broken electrical line, and the HEPA filters could provide the initial combustion fuel.

4.6.3.2 Source Term. The source term is based on the discharged exhaust from 296-S-21 Stack, which is continuously sampled and periodically analyzed. Emissions reported for Calendar Year 1989 were reported as <3.33 x 10^{-6} Ci for gross alpha and 1.78 x 10^{-5} Ci for gross beta (Brown et al. 1990). Application of a decontamination factor of 3,333 (1/1 efficiency, where HEPA efficiency is 99.97%) to simulate loss of HEPA filtration gives a source strength of ~1.1 x 10^{-2} Ci and ~5.9 x 10^{-2} Ci gross alpha and beta, respectively. Based on past operations and facility mission, it is assumed that the HEPA filters will not be replaced for 20 years; therefore, the gross alpha and beta values have been multiplied by 20 or 0.24 Ci for gross alpha and 1.18 Ci for gross beta. Based on the estimated facility inventory, it is assumed that all gross alpha is ^{239}Pu and all gross beta is ^{90}Sr. Table 4-16 provides the source term of ^{239}Pu and ^{90}Sr that would be released from a fire.

The release fraction/respirable fraction (1.0 x 10^{-4}/1.0) is based on experimental data from the burning of both used and removed-from-service HEPA filters due to high differential pressures as reported in Ammerich et al (1989). The source term in Table 4-16 was developed by applying the following:

(curies) x (release fraction) x (respirable fraction).

Table 4-16. High-Efficiency Particulate Air Filter Fire Source Term.

Radionuclide	HEPA filter inventory (Ci)	Release fraction	Source term (Ci)
^{239}Pu	0.24	1.0 E-04	2.4 E-05
^{90}Sr	1.18	1.0 E-04	1.18 E-04

HEPA = high-efficiency particulate air (filter).

4.6.3.3 Consequences. The dose consequences for a postulated fire in the 222-SC Filter Building have been calculated using the source term provided in Table 4-17. The consequences have been evaluated against the guidelines outlined in Section 4.5.

Table 4-17. Dose Consequences for the High-Efficiency Particulate Air Filter Fire.

Receptor	Dose		Guidelines	
	EDE (rem)	Organ (rem)	EDE (rem)	Organ (rem)
Onsite (900 m)	2.6 E-03	4.7 E-02 (bone surface)	≤5	≤50
Offsite (13.5 km)	5.7 E-05	1.0 E-03 (bone surface)	≤0.5	≤5

EDE = effective dose equivalent.

4.6.4 Dropped Coverblock at the 219-S Waste Handling Facility

Maintenance activities may require the removal of the 4,080-kg (9,000-lb) concrete cover blocks enclosing the operating gallery, pipe chases, and stainless steel tanks of the 219-S Waste Handling Facility. It is conceivable that the coverblock could be dropped during removal or replacement, causing major structural damage to the piping and waste holding tanks.

4.6.4.1 Accident Scenario. Periodic maintenance on the tanks requires crane truck removal of the coverblocks to expose the vaults containing the tanks and to allow access. The coverblock is raised over TK-102, the neutralization and transfer tank. It is postulated that as the boom approaches the height to allow the crane truck to back away from the vaults, the boom support pins shear from metal fatigue, and the coverblock crashes into the tank. The tank is severely damaged, its entire contents are released into the vault, and misting aerosols from the impact rise from the vault.

4.6.4.2 Source Term. An operational safety document limits the operating capacities of the tanks in the 219-S Waste Handling Facility. TK-101 is limited to 13,625 L (3,600 gal), TK-102 to 13,625 L (3,600 gal), and TK-103 to 4,770 L (1,260 gal). All operating limits are well above standard operating levels. The source term results from a 12,870-L (3,400-gal) release from the facility's maximum design capacity of 35,960 L (9,500 gal). The operating capacity is 29,750 L (7,860 gal). The maximum tank inventory, shown in Table 4-18, represents 10% of the total facility inventory.

The release fraction/respirable fraction ($4.0 \times 10^{-5}/0.7$) is based on experimental data from a free-fall spill of aqueous solutions with a fall distance of 3 m or less as reported in Sutter et al (1981). The source term in Table 4-18 was developed by applying the following:

(maximum tank inventory[curies]) x (release fraction) x (respirable fraction).

4.6.4.3 Consequences. The dose consequences for a postulated dropped coverblock in the 219-S Waste Handling Facility have been calculated using the source term provided in Table 4-19. The consequences have been evaluated against the guidelines outlined in Section 4.5.

Table 4-18. 219-S Facility Inventory and Respirable Fraction.

Radionuclide	Maximum tank inventory[a] (Ci)	Source term[b] (Ci)
^{3}H	4.09 E-01	1.15 E-05
^{14}C	1.29 E-02	3.61 E-07
^{60}Co	8.68 E-01	2.43 E-05
^{90}Sr	5.01 E+01	1.40 E-03
^{99}Tc	1.06 E-01	2.97 E-06
^{129}I	9.36 E-02	2.62 E-06
^{137}Cs	1.27 E+02	3.56 E-03
^{147}Pm	1.53 E+01	4.27 E-04
^{238}Pu	4.37 E-02	1.22 E-06
^{239}Pu	3.71 E-01	1.04 E-05
^{241}Am	2.41 E-01	6.76 E-06
^{234}U	3.92 E-02	1.10 E-06
^{235}U	1.15 E-03	3.22 E-08
^{238}U	2.67 E-03	7.47 E-08

[a]This column represents the inventory in terms of 10% of the 222-S Laboratory inventory.

[b]These values represent the respirable source term upon applying the release fraction/respirable fraction discussed in Section 4.6.4.2.

Table 4-19. Dose Consequences for Coverblock Drop.

Receptor	Dose		Guidelines*	
	EDE (rem)	Organ (rem)	EDE (rem)	Organ (rem)
Onsite (900 m)	2.08 E-03	3.6 E-02 (bone surface)	≤5	≤50
Offsite (13.5 km)	4.4 E-05	8.0 E-04 (bone surface)	≤0.5	≤5

*See Table 4-9.
EDE = effective dose equivalent.

4.6.5 Vehicle-Induced Spills

Truck and heavy equipment traffic in and around the 222-S Laboratory is common. In support of laboratory functions, bulk chemical storage, low-level waste drum storage, and a temporary storage and disposal area are interspersed within the facilities. Inadvertent collisions with containers and storage vessels represent another mode for hazardous material release and potential worker exposure or injury and environmental contamination. The facilities and areas that may be affected by such incidents include the 222-S Temporary Storage and Disposal area, 222-SD Drum Storage Facility, 2716-S Storage Building, nitric acid storage vessel, and 219-S Caustic Tank.

NOTE: Storage drums at both the 222-S Temporary Storage and Disposal area and 222-SD Drum Storage Facility are limited to type A quantities (10 CFR 61) and are considered to present less risk than the chemical source term.

4.6.5.1 Accident Scenario. Directly north and ≈23 m (25 yd) from door 2A is a 3,200-L (850-gal) stainless steel tank container within a concrete-reinforced berm that is ≈0.9 m (3 ft) high and surrounds an area of ≈5.4 m^2 (58 ft^2). The bermed containment easily holds the entire contents of the tank's operating limit of 2,460 L (650 gal), 16 *M* nitric acid. While pumping the contents to or from the tank delivery truck, it is conceivable that a large spill onto the asphalt could be induced by a faulty valve on the tanker truck, operator error such as driving away during pumping, or an inadvertent collision into the valve or hoses. It is assumed that 378 L (100 gal) of nitric acid would be released as a result of an accident during the nitric acid transfer operations (see Table 4-20). This assumption is based on operations at the facility. That is, the delivery and the transfer of nitric acid to the acid tank is observed by the delivery and facility personnel; therefore, should a release occur, the release would be detected visually, and transfer operations would be stopped immediately.

4.6.5.2 Source Term.

Table 4-20. Tanker Truck Transfer Spill Source Term.

Volume	378.5 L (100 gal)
Surface area of spill	9.29 m^2 (100 ft^2)
Temperature	Liquid 27 °C (80 °F), Ambient 38 °C (100 °F)
Stability Class	F
Wind Speed	4 m/s

4.6.5.3 Consequences.

Table 4-21 provides the consequences caused by a release of 378 L (100 gal) of nitric acid during transfer operations.

Table 4-21. Exposure Consequences for Vehicle-Induced Spills.

Distance	Exposure (ppm)	Guidelines (ppm)
Onsite (900 m)	0.15	15 (ERPG-2)
Offsite 13.5 km	3.3 E-03	2 (ERPG-1)

ERPG = Emergency Response Planning Guidelines (AIHA 1991).

4.7 QUEST DATA FOR UNUSUAL OCCURRENCES

In addition to the PHA for the identification of hazards, the occurrence data from the 222-S Laboratory were evaluated to characterize the types of hazards that have occurred from 1987 through 1993. Because these data depict the normal operating environment, the data help to ensure that all possible accidents and/or hazards have been identified and incorporated into the PHA.

The data were categorized in 29 different events and 4 different root-cause categories (Table 4-22).

Based on the evaluation of the data, the six most frequently reported events are contamination (25%), fire-industrial equipment (9.4%), personnel injury (6.9%), hazardous material (6.3%), and both radiation monitoring and handling/shipping (5.6 %). Contamination results from the spread of radioactive material located in nonradiation areas or radioactive contamination of employee skin, clothing, or equipment. Fire industrial equipment occurrences are the result of false fire alarms. Personnel injury occurrences involve injuries resulting from chemical spills, lifting, cuts, burns, slips, or falls. Hazardous material occurrences involve chemical/acid spills. The occurrences for radiation monitoring were reported for failure of the CAMs. Handling/shipping occurrences range from the accidental drop of a nonradiological sample to the improper shipping of radiological samples.

Evaluation of these data revealed industrial events that are typical of industrial operations with exception to radiological hazards as indicated in Table 4-21. However, events with the potential to impact receptors of concern if not addressed were incorporated into the PHA for further evaluation. Although many of the events obtained through the occurrence data effected primarily facility workers, the data provided a method (checklist) of determining if all possible hazards of concern were identified and evaluated in the PHA.

Table 4-22. Occurrence Report Matrix.

Subject event	Root cause				Total
	Equipment	Other	Procedure	Personnel	
Administrative					
Procedures	1			5	6
Personnel Injury	5	3	1	5	14
Environmental	1				1
Corrective action management				1	1
Event					
Fire	2				2
Contamination	10	7	1	22	40
Exposure	1			1	1
Vehicle accident				1	1
Hazardous material	5			5	10
Security				1	1
Hardware					
Piping	2	1			3
Electrical	4	1		1	6
HVAC	5	1		2	8
Structural	1				1
Fire industrial equipment	11	1	1	2	15
Valves	4	2		2	8
Pumps	1				1
Motors	1				1
Vessels	2				2
Material	2				2
Safety equipment	2				2
Computer				1	1
Rad monitoring	3	3	1	2	9
Process					
Fab/install	1				1
Testing monitoring		1		4	5
Material transfer	2				2
Chemistry			1	3	4
Handling/shipping			3	6	9
Storage	1			1	2
Total	67	20	8	65	160

HVAC = heating, ventilating, and air conditioning.

4.8 DISPERSION MODELLING

To provide uniform dose and exposure projections throughout the WHC safety analysis work scope, WHC has adopted the use of certain codes. In addition, the Hanford Environmental Dose Overview Panel (HEDOP) was established to provide verification of the applicability of the input parameters and the assumptions to derive the input parameters and model selection algorithms of the codes. The codes used to project dose and exposure are described in the following sections. All code input and output, including the HEDOP review, is provided in the appendices.

4.8.1 GENII Environmental Dosimetry Code

The radiation doses for the releases following accidents described in Sections 4.3, 4.6.3, and 4.6.4 are calculated using the computer code GENII (Napier et al. 1988). The code was written to analyze environmental releases resulting from acute or chronic releases to air, water, or soil and uses methods consistent with International Commission on Radiological Protection (ICRP) 26 and 30 (ICRP 1977 and 1979). Results are listed using the units of rem effective dose equivalent (EDE) as defined in DOE Order 5400.5.

The EDE is the sum of the products of the dose equivalent received by different tissues of the body and their tissue-specific weighting factor. This sum is a measure of relative risk and can be used to provide a comparison of the individual relative risk of cancer death against those established for populations (consult ICRP 26 for the basis of tissue-specific weighting factors and how they relate to uniform whole-body irradiation). The EDE includes the 50-year committed EDE from internal radionuclide deposition and the EDE resulting from external exposure to penetrating radiation. The EDE is expressed in units of rems.

NOTE: GENII does not perform calculations to determine skin dose. This is in conformance with the nature of the waste product produced at the Hanford Site.

The atmospheric dispersion between the release point and a receptor is modeled as a straight-line Gaussian plume with no terrain effects and is based on Hanford-Site-specific meteorological data collected from 1983 to 1987. The code evaluates doses from several pathways, including inhalation, submersion, ingestion, and ground contamination.

The code was developed in accordance with American Society of Mechanical Engineers (ASME) NQA-1 (ASME 1989) and is described in three volumes of documentation. Volume 1 describes the theoretical considerations of the system, Volume 2 is a user's manual, and Volume 3 is a code maintenance manual. These manuals should be consulted if more detailed information is desired.

The GENII package of codes uses standard models whose reliability and stability are accepted in the industry. The GENII package has been developed under the Pacific Northwest Laboratory (PNL) *Quality Assurance Manual*, PNL-MA-70 (PNL 1989), "Procedures for Quality Assurance Program," whose base is ASME NQA-1 (ASME 1989). The package has been verified to show that it generates correct solutions for each of the encoded mathematical models used.

Additionally, a comparable solution has been produced for each model by hand calculation. WHC Safety Support Services maintains system configuration control in accordance with procedure WHC-SD-SQA-CSCM-301, *Software Configuration Control for Safety Support Services* (Kummerer 1990).

4.8.2 Automated Resource for Chemical Hazard Incident Evaluation

The ARCHIE software was developed by the U.S. Department of Transportation, the Federal Emergency Management Agency, and the Environmental Protection Agency for use by emergency preparedness personnel. ARCHIE contains several models, including the following:

- Nine methods for estimating discharge rate and duration of gas or liquid release from a tank or pipe
- Seven methods to help the user estimate the size of any liquid pools that can form on the ground
- Two methods to estimate the rate at which a liquid pool will evaporate or boil
- A dispersion model that calculates downwind concentrations of toxic chemicals and the area affected (Gaussian model)
- A method to evaluate thermal radiation hazards resulting from pool fires
- Methods to evaluate hazards of vapor phase explosions and condensed phase explosions
- A method to evaluate hazards relating to tank overpressurization explosions.

The ARCHIE software does not contain a chemical library and requires that the thermochemical parameters be supplied for each chemical for which calculations are done. This is not a major disadvantage because the thermodynamic information required by the ARCHIE model is generally straightforward and readily available. If a particular thermodynamic parameter for a given chemical is not readily available in the literature, other software products can be used to estimate most parameters within a few percent. Because the ARCHIE software is not tied to a limited library of chemical compounds, it is quite flexible.

4.8.3 MICROSHIELD

Microshield is used to analyze the shielding of gamma radiation. Examples of the use of this type of analysis include shielding design, container design, temporary shielding selection, source strength inference from radiation measurements, ALARA planning, and teaching. This program is a microcomputer adaptation of the main frame code ISOSHLD, a public domain "point kernal" code first written in the early 1960's. User interaction with the computer has been enhanced for data input and display of results. Microshield operates on the IBM-PC series of computers, or equivalent, with Disk Operating System Version 2.1 or later.

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5.0 SAFETY EQUIPMENT LIST

The 222-S Laboratory Facilities have been analyzed and determined to be Category 3 as specified in DOE Order 5480.23 from the guidance contained in DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Techniques* (DOE 1992). As defined in DOE-STD-1027-92, nuclear hazard Category 3 facilities are those facilities that present the potential for only significant localized consequences. Based on the results of the hazard categorization and the accident analysis of the 222-S Laboratory provided in Chapter 4.0, no mitigating features are required to maintain onsite or offsite radiological or toxicological consequences within guideline values.

5.1 METHODOLOGY

To define the systems and components designated as "safety class," an evaluation of the consequences of the potential hazards and postulated unmitigated beyond-design-basis accidents were compared against the criteria (defined in Table 5-1) established by MRP 5.46, "Safety Classification of Systems, Components, and Structures," contained in WHC-CM-1-3, *Management Requirements and Procedures*. From this analysis, those systems and components identified as safety class are listed with the equipment name, the part number, if applicable, and safety class. This is known as the safety equipment list (Table 5-2). This chapter summarizes the methods used to establish the safety equipment list for the 222-S Laboratory.

The first step in identifying the safety equipment list is to determine the potential consequences of the postulated accidents. The accident analysis includes all those accidents that were identified in the PHA and considered bounded in the analyses provided in Chapter 4.0 of this document.

The projected consequences of all accidents evaluated in Chapter 4.0 were well below the criteria establishing safety class 2, as defined in Table 5-1. Additionally, analysis was performed to evaluate the potential safety class resulting in environmental contamination from large releases (219-S), defined as Environmental Hazard Safety Classification (EHSC) (MRP 5.46), even though the projected doses and exposures fall below safety class 2.

The analysis followed the steps outlined in Appendices B and C in MRP 5.46 (WHC-CM-1-3). For this analysis, both a radiological and toxicological release to the soil column were evaluated. A release of the entire contents of the three holding tanks in the 219-S Waste Handling Facility produces an EHSC value below that defining safety class 2 (refer to Appendix B). Also, values produced from releasing the total contents of the 3,200-L (850-gal) nitric acid storage tank fall below safety class 2 criteria.

Table 5-1. Safety Class Criteria.

Assign Safety Class 2 to systems, components, and structures, including portions of process systems, whose failure could:	
PERSONNEL SAFETY	
1	Result in exposure in excess of 5 rem EDE for the onsite worker.
2	Result in airborne concentration of toxic material, for the onsite worker, in excess of the applicable chemical ERPG-3 limit.
3	Result in exposure in excess of 5 rem EDE or an airborne concentration of nonradiological hazardous material in excess of the applicable chemical ERPG-3 limit to facility operators, which are relied upon to perform the safe shutdown function of criterion 5.
ENVIRONMENTAL PROTECTION	
4	Result in an EHSC value <1,000,000 and ≥500,000. Refer to Appendices C and D of WHC-CM-6-1 and to MRP 5.46 of WHC-CM-1-3. The EHSCs due to nonradiological hazardous material and radioactive material are applied separately for this criterion.
SAFE SHUTDOWN AND OPERATION	
5	Preclude safely placing or maintaining the operating process in a safe shutdown condition where the consequences to the onsite worker or the environment may exceed criterion 1, 2, or 4 above.
6	Prevent monitoring the accidental release of radioactive material and/or nonradiological hazardous material to the environment during and after a DBA, where the monitor's output initiates emergency response plan actions or operator actions to place the operating process in a safe condition per criterion 5 above.
7	Preclude maintaining operating parameters within the operational safety requirements that protect the environment (per criterion 4) or the onsite worker (per criterion 1 or 2).
EQUIPMENT INTERACTION	
8	Prevent a separate safety class 2 system, component, or structure from performing its safety or environmental protection function, either by loss of control function or by damage.

DBA = design basis accident.
EDE = effective dose equivalent.
EHSC = Environmental Hazard Safety Classification.
ERPG = Emergency Response Planning Guidelines (AIHA 1991).

Table 5-2. Safety Equipment List. (2 sheets)

Safety class designation	Safety class system/ structure	Safety class component	Bases for designation
I	No systems/structures identified	Not applicable	Not applicable
II	No systems/structures identified	Not applicable	Not applicable
III	222-S Building confinement structure	Not applicable	BDBA Chapter 4.0 PHA, seismic event-fire, unmitigated worst-case accident, EHSC Appendix B
	222-S final HEPA filters	HEPA filters	Exhaust HEPA filters; protection of environment. Bounded by Chapter 4.0 PHA
	Hot Cells 1A, 1E1, 1E2, and 1F shielding	Leaded glass, shielding walls	Hot cell shields; protection of facility worker
	207-SL Retention Basin	Concrete structure, outlet valves, transfer lines	207-SL Retention Basin; protection of environment. Bounded by EHSC completed on 219-S Waste Handling Facility
	Nitric acid containment pit	Concrete basin, stainless steel tank, transfer piping	Nitric acid storage containment pit; protection of environment, EHSC Appendix B
	296-S-21 Main exhaust stack monitor	Alpha CAM, beta/gamma CAM, record sampler holder, flowmeter, local alarm box	No specific accident applicable; bounded by accident analyzed in Chapter 4.0 PHA
	Fume hood	Not applicable	Chapter 4.0 PHA; protection of facility worker
	Sample shipping containers	Not applicable	Chapter 4.0 PHA; radiological hazards; sample spills, protection of facility worker
	Vacuum air sampling system	Not applicable	No specific accident applicable; protection of facility worker
	CAMs	Not applicable	No specific accident applicable; protection of facility worker
	Electric exhaust fans K1-1-1 and K1-1-2	Not applicable	Chapter 4.0 PHA; protection of facility worker
	Diesel exhaust fan K1-2-1	Not applicable	Chapter 4.0 PHA; protection of facility worker
	Sample storage units	Not applicable	Chapter 4.0 PHA; spills, radiological toxicological hazards; sample spills, protection of facility worker.
	222-SC HEPA filters	Not applicable	Chapter 4.0 PHA, protection of facility worker
	Fire detection and alarm system	Not applicable	Chapter 4.0 PHA; protection of facility worker
	Fire protection system	Not applicable	Chapter 4.0 PHA; protection of facility worker
	Water sprinkler fire protection system	Not applicable	Chapter 4.0 PHA; protection of facility worker

Table 5-2. Safety Equipment List. (2 sheets)

Safety class designation	Safety class system/ structure	Safety class component	Bases for designation
	Carbon dioxide fire protection system	Not applicable	Chapter 4.0 PHA; protection of facility worker
	EPAX telephone paging system	Not applicable	No specific accident applicable; protection of facility worker
	Safety showers and eyewashes	Not applicable	No specific accident applicable; protection of facility worker
	Fire doors	Not applicable	No specific accident applicable; protection of facility worker
	Emergency egress lighting	Not applicable	No specific accident applicable; protection of facility worker
	Cranes, hoists, and lifting equipment	Not applicable	No specific accident applicable; protection of facility worker

BDBA = beyond-design-basis accident.
CAM = continuous air monitor.
EHSC = Environmental Hazard Safety Classification.
HEPA = high efficiency particulate air (filter).
PHA = preliminary hazards analysis.

5.2 SUMMARY/CONCLUSIONS

Based on the accident sequences analyzed in Chapter 4.0, none of the consequences result in a radiological or toxicological exposure in excess of the criteria stated in Table 5-1. Large releases of radioactive and toxic material also were evaluated to define the EHSC. These results also are below criteria defining safety class 2. Accordingly, all systems and components of the 222-S Laboratory are considered no greater than safety class 3.

222-S LABORATORY

INTERIM OPERATIONAL SAFETY REQUIREMENTS

PREFACE

These Interim Operational Safety Requirements (IOSR) for the 222-S Laboratory define acceptable conditions, safe boundaries, bases thereof, and management or administrative controls required to ensure safe operation of the 222-S Laboratory.

This IOSR and its appendices constitute an agreement or contract between DOE and WHC regarding the safe operation of the 222-S Labs. As such, the IOSR cannot be changed without the approval of the Program Secretarial Officer (PSO), or designee.

The scope of this IOSR is based on the 222-S Laboratory Interim Safety Basis (ISB) (Lavender 1994).

This IOSR has been included with the 222-S Laboratory ISB (Lavender 1994). The numbering and wording of the IOSR sections have been maintained for consistency with the Department of Energy (DOE 5480.22) and WHC policy (WHC-CM-4-46) on Technical Safety Requirements (TSR). The sections that are not applicable to the 222-S Laboratory are noted throughout the IOSR.

TABLE OF CONTENTS

List of Terms

AC	Administrative Control
ALARA	As Low As Reasonably Achievable
DOE	U.S. Department of Energy
FSAR	Final Safety Analysis Report
IOSR	Interim Operational Safety Requirement
ISB	Interim Safety Basis
LCO	Limiting Condition for Operation
LCS	Limiting Control Setting
NA	Not Applicable
PRC	Plant Review Committee
PSO	Program Secretarial Officer
SAR	Safety Analysis Report
SL	Safety Limit
SR	Surveillance Requirement
WHC	Westinghouse Hanford Company

Section 1 USE AND APPLICATION

1.1 Definitions

---NOTE---

The defined terms of this section are unique definitions. They appear in CAPITALIZED type and are applicable throughout these Interim Operational Safety Requirements (IOSR) and BASES. Some terms in this Section refer the user to another Section for the definition. This has been provided to prevent a shortened definition from being supplied and used out of context.

Term	Definition
BASES	BASES shall be pertinent information and details supporting IOSR elements and specific values or characteristics (see Appendix B, BASES).
MODE	MODEs are used to define the operational condition of the facility. See Section 1.2, MODES.
VIOLATION	VIOLATIONS of the IOSR occur as the result of any of three circumstances. For all circumstances, should a VIOLATION occur, DOE will be notified and an Occurrence report will be prepared in accordance with AC 5.2 Occurrence Reporting. The three circumstances are listed below: A. Failure to take the ACTIONS required within the required time limit following: 1. Failure to meet a LCO. 2. Failure to successfully meet a SR. B. Failure to perform a Surveillance within the required time limit. C. Failure to comply with an AC requirement. (Failure to follow a procedure within a required program does not necessarily constitute a violation.)

1.2 MODES

The following defined MODES are to be applied to the 222-S Laboratory:

OPERATION	The facility is conducting its normal activities such as receiving, decontaminating, processing, examining, analyzing, and repackaging or storing radioactive and mixed waste material. Facility maintenance and surveillance may be occurring.
RESTRICTED	Receipt of additional radioactive material containers is not allowed. Handling and processing of radioactive and mixed waste material located in the facility is not allowed. Radioactive material containers are stored in the designated storage areas. Facility maintenance and surveillance will be occurring which does not involve handling of radioactive material containers.

1.3 Safety Limits (SLs)

(Not Applicable for 222-S Laboratory per WHC-CM-4-46)

1.4 Limiting Control Settings (LCSs)

(Not Applicable for 222-S Laboratory)

1.5 Limiting Conditions for Operation (LCOs)

LCOs are the lowest functional capability or performance level of safety-related structures, systems, components, and their support systems required for normal safe operation of the facility.

LCOs shall be based upon maintaining conditions within specified limits or that the systems and structures operable, which are required for the protection of the public, onsite personnel, facility worker, and the environment from radiological consequences.

Process variables such as the maximum bounding inventory used in the facility hazard categorization or the accident analysis to establish the facility hazard category and/or define the safe operation of the facility, shall also be considered LCOs.

1.6 Surveillance Requirements (SRs)

SRs are requirements relating to testing, calibration, or inspection to ensure that the necessary operability and quality of safety-related structures, systems, components, and their support systems, or specified conditions required for safe operation of the facility, are maintained.

1.7 Administrative Controls (ACs)

ACs are the provisions relating to organization and management, procedures, recordkeeping, reviews, and audits necessary to ensure safe operation of the facility.

Facility specific programs and provisions are established and committed to in the 222-S Laboratory ISB (Lavender 1994) to ensure the safe operation of the facility. These programs include inventory control, configuration management, and organization.

Section 3 LIMITING CONDITIONS FOR OPERATION

3.0 LIMITING CONDITIONS FOR OPERATION (LCO) APPLICABILITY

LCO 3.0.1 LCO Met	LCOs shall be met during the MODES or other specified conditions in the Applicability, except as provided in LCO 3.0.2, ACTION Met.
LCO 3.0.2 ACTION Met	Upon discovery of a failure to meet a LCO, the Required Actions of the associated Conditions shall be met. If the LCO is met or is no longer applicable prior to expiration of the specified Completion Time(s), completion of the Required Action(s) is not required unless otherwise stated.
LCO 3.0.3 ACTION Not Met or ACTION Not Provided	When a LCO is not met, and the associated ACTIONS are not met or an associated ACTION is not provided, the facility shall be placed in a MODE or other specified condition. Action shall be initiated within 1 hour to place the 222-S Laboratory, as applicable, in: a. RESTRICTED MODE within 4 hours Exceptions to this LCO are stated in the individual LCOs. Where corrective measures are completed that permit operation in accordance with the LCO CONDITION or ACTIONS REQUIRED, completion of the actions required by LCO 3.0.3 is not required. LCO 3.0.3 is applicable in all MODES.
LCO 3.0.4 MODE Changes	When a LCO is not met, entry into a MODE or other specified condition in the Applicability shall not be made except when the associated ACTIONS to be entered permit continued operation in the MODE or other specified condition in the Applicability for an unlimited period of time. This LCO shall not prevent changes in MODES or other specified conditions in the Applicability that are required to comply with ACTIONS. Exceptions to this LCO are stated in the individual LCOs. These exceptions allow entry into MODES or other specified conditions in the Applicability when the associated ACTIONS to be entered allow facility operation in the MODE or other specified condition in the Applicability only for a limited period of time.

LCO 3.0.7 Emergency Exceptions	Emergency actions may be taken that depart from the approved Interim Operational Safety Requirements (IOSR) when no actions consistent with the IOSR are immediately apparent, and when these actions are needed to protect the facility worker, onsite individual, or the public health and safety. Such actions shall be approved, as a minimum, by a Senior Chemical Technologist or Manager/Supervisor. **If emergency actions are taken, verbal notifications shall be made to the Head of the Field Element within 2 hours and by written reports to the Program Secretarial Officer (PSO) within 24 hours, in accordance with Section 5.4, Occurrence Reporting.**

3.1 222-S Radiological Inventory

3.1.1 Radiological Inventory Limit

LCO 3.1.1 The 222-S Laboratory radiological inventory will remain ≤ the following values for each constituent.

Radionuclides	Curies
H-3	4.08E+00
C-14	1.28E-01
Co-60	8.64E+00
Sr-90	5.00E+02
Tc-99	1.06E+00
I-129	9.32E-01
Cs-137	1.26E+03
Pm-147	1.52E+02
Pu-238	4.36E-01
Pu-239	1.10E+01
Am-241	2.40E+00
U-234	3.90E-01
U-235	1.14E-02
U-238	2.66E-02
Cf-252*	5.14E-02

* Contained in a DOT approved container; therefore, excluded from Hazard Categorization

APPLICABILITY: OPERATION and RESTRICTED MODES

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. The specified limit for a radionuclide has been exceeded.	A.1.1	Stop all receipt of radioactive materials.	1 hour
	<u>AND</u>		
	A.1.2	Then be in RESTRICTED MODE.	4 hours
	<u>AND</u>		
	A.2	Then develop and submit to DOE a Recovery Plan.	7 days
	<u>AND</u>		
	A.3	Then implement the DOE approved Recovery Plan.	Per the Completion Time of the Recovery Plan

Section 4 SURVEILLANCE REQUIREMENTS

4.0 SURVEILLANCE REQUIREMENT (SR) APPLICABILITY

SR 4.0.1 SR Met	SRs shall be met during the MODES or other specified conditions in the Applicability for individual LCOs, unless otherwise stated in the SR. Failure to meet a Surveillance, whether such failure is experienced during the performance of the Surveillance or between performances of the Surveillance, shall be failure to meet the LCO. Failure to perform a Surveillance within the specified Frequency shall be failure to meet the LCO except as provided in SR 3.0.3, Delay of Required Actions.
SR 4.0.2 Delay of Required Actions	If it is discovered that a Surveillance was not performed within its specified Frequency, then compliance with the requirement to declare the LCO not met may be delayed, from the time of discovery, up to 24 hours or up to the limit of the specified Frequency, whichever is less. This delay period is permitted to allow performance of the Surveillance. If the Surveillance is not performed within the delay period, the LCO must immediately be declared not met, and the applicable Condition(s) must be entered. The Completion Times of the Required Actions begin immediately upon expiration of the delay period. When the Surveillance is performed within the delay period and the Surveillance is not met, the LCO must immediately be declared not met, and the applicable Condition(s) must be entered. The Completion Times of the Required Actions begin immediately upon failure to meet the Surveillance.
SR 4.0.3 MODE Changes	Entry into a MODE or other specified condition in the Applicability of a LCO shall not be made unless the LCO's Surveillances have been met within their specified Frequency. This provision shall not prevent passage through or to MODES or other specified conditions in compliance with Required Actions.

4.1 222-S Radiological Inventory

SURVEILLANCE		FREQUENCY
SR 4.1.1	Recalculate a radionuclide materials inventory.	Upon receiving radionuclide materials.

Section 5 ADMINISTRATIVE CONTROLS

5.1 Organization

5.1.1 Lines of authority, responsibility, and communication shall be established and defined for the highest management levels through intermediate levels to and including all safety and operating organization positions. These relationships shall be documented and updated, as appropriate, in the form of organization charts, functional descriptions of departmental responsibilities and relationships, and job descriptions for key personnel positions, or in equivalent forms of documentation.

The individuals who train the operating staff and those who carry out safety and quality assurance functions shall have sufficient organizational freedom to ensure their independence from operating pressures.

The contractor is responsible for ensuring that the requirements of the 222-S Laboratory IOSR are met. Compliance shall be demonstrated by:

a. Operating within the Limiting Conditions for Operation (LCOs), and the associated Surveillance Requirements (SRs) during their Applicability,

b. Operating within the ACTIONS of LCOs when required,

c. Performing all SRs as required,

d. Establishing, implementing, and maintaining the required ACs.

5.1.1.1 Manager - 222-S Laboratory

The 222-S Laboratory Manager shall be responsible for safe operation within the 222-S Laboratory. Safe operation shall include, as necessary, interface requirements with other onsite organizations and facilities.

5.1.1.2 Minimum Operations Shift Complement

The number of facility managers and operators available shall be adequate to operate and support 222-S Laboratory safely. Abnormal plant conditions shall be considered in determining operator assignments. Management shall provide additional personnel, as necessary, to support other activities.

The minimum operations shift complement per shift for 222-S Laboratory shall be as follows:

MINIMUM OPERATIONS SHIFT COMPLEMENT

	OPERATION*	RESTRICTED*
Facility Manager	1	1
Operator (Senior Chemical Technologist)	1	1

* See LCO 3.0.7

5.1.1.3 The minimum complement can be 1 less than the required number for a period of time not to exceed 2 hours in OPERATION or RESTRICTED MODES, to accommodate unexpected absences, provided immediate action is taken to restore the shift complement to within the minimum requirements. (See also LCO 3.0.7)

5.1.1.4 Engineers, Chemists, or managers who are also trained in an approved training program, including facility specific operating procedures, may be substituted for operators.

5.2 Occurrence Reporting

5.2.1 Requirement for Occurrence Reporting

A program shall be established, implemented, and maintained for occurrence reporting of events and conditions, that may involve safety, health, quality, safeguards, security, or environmental implications. It is the policy of WHC that occurrences be consistently reported to assure that both DOE and WHC line management are kept fully and currently informed of all events that could: (1) affect the health and safety of the public; (2) seriously impact the intended purpose of DOE facilities; (3) have a noticeable adverse effect on the environment; or (4) endanger the health and safety of workers.

5.2.2 If a VIOLATION of a LCO, SR, or AC occurs, proceed as follows:

a. Notify the DOE and WHC of the VIOLATION in accordance with their respective occurrence reporting requirements.

b. Prepare an Occurrence Report in accordance with DOE and WHC occurrence reporting requirements.

c. Prepare a recovery plan, if required, describing the steps leading to operation in a compliant condition.

5.3 Nuclear Criticality Safety

(Not applicable for 222-S Laboratory, for bases see Inventory Control LCO 3.1.1)

5.4 222-S Laboratory Inventory Control

5.4.1 Requirement for 222-S Laboratory Inventory Control

A program shall be established, implemented, and maintained for 222-S Laboratory inventory control. The program shall be based on maintaining the total inventory of radioactive material at values that maintain 222-S Laboratory as a Category 3 Nuclear Facility as discussed in the *Hazard Categorization Report for the 222-S Laboratory* (Bourger 1993) and the *222-S Laboratory Interim Safety Basis* (Lavender 1994). The program shall include procedures and auditable records that assure the 222-S Laboratory remains at or below the accident analysis source term assumption limits.

Section 6 REFERENCES

The following references are for the IOSR and its Appendices:

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Lavender 1994, *222-S Laboratory Interim Safety Basis*, WHC-SD-CP-ISB-002, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC, *Nonreactor Facility Safety Analysis Manual*, WHC-CM-4-46, Westinghouse Hanford Company, Richland, Washington.

Appendix B BASES

This Appendix provides summary statements of the reasons for the Limiting Conditions for Operation and the associated Surveillance Requirements. The BASES describe how the limit(s), the Applicability, the Condition(s), and the Surveillance(s) will maintain operation of the facility within the safety envelope. The primary purpose for describing the BASES for these requirements is to provide the operations and engineering staff with the necessary information to maintain operation of the facility within the safety envelope and to ensure that any future changes to these requirements will not affect their original intent or purpose.

B 3.0 LIMITING CONDITIONS FOR OPERATION (LCOs) AND SURVEILLANCE REQUIREMENTS (SRs)

BASES

B 3.1 222-S Radiological Inventory

B 3.1.1 Radiological Inventory Limit

BACKGROUND	The purpose of establishing a radioactive constituent concentration limit for the 222-S Laboratory is to assure that concentrations in the 222-S Laboratory stay within the bounds established for the design basis accidents in Section 4 of the *222-S Laboratory Interim Safety Basis* (Lavender 1994). The limit also assures the 222-S Laboratory will remain within the analyzed designation of a Category 3 Nuclear Facility (Lavender 1994).
APPLICABLE SAFETY ANALYSES	The design basis accident and the preliminary hazards analyses used the source term identified in the LCO for the bounding worst-case accident for the 222-S Laboratory. The LCO has been established to assure these limits are not exceeded.
LCO	The LCO is established at the accident analysis radiological constituent source term limits. This limit is the upper bound of operation for the 222-S Laboratory. The LCO and associated SR are intended to alert facility management to abnormal concentrations in the 222-S Laboratory and to conservatively maintain the 222-S Laboratory within the accident source term inventory limits.
APPLICABILITY	The LCO applies to all facility MODES. The concentration limits in the 222-S Laboratory must remain at or below the LCO at all time to remain within the analyzed safety envelope defined in Section 4 of the 222-S Laboratory Interim Safety Basis (Lavender 1994).
ACTIONS	<u>A.1.1</u> Samples containing radionuclide materials are received at the laboratory. The samples are then added to the cumulative inventory to determine if the LCO limit has been maintained. If it is discovered that the 222-S Laboratory has exceeded the limit of an LCO specified radionuclide the immediate action is to stop all receipt of radionuclide materials. The total of one hour is allowed for stopping receipt of radionuclide materials.

ACTIONS	A.1.2 The completion time of four hours for placing the 222-S Laboratory in RESTRICTED MODE is considered sufficient time to carry out the mode change in an orderly fashion and place the 222-S Laboratory in a safe condition. A.2 Development and submittal to DOE of a Recovery Plan within 7 days allows for the appropriate level of management and oversight involvement to verify and evaluate the out of specification condition. A.3 The Completion Time for the implementation of the Recovery Plan is dependent on the complexity of the recovery actions for each unique situation. Not completing the actions of the DOE approved Recovery Plan would result in an LCO VIOLATION.
SURVEILLANCE REQUIREMENTS	SR 3.1.1 A radionuclide materials inventory will need to be calculated, upon receiving a sample or samples at the 222-S Laboratory. The inventory is the current cumulative inventory, plus the additional radionuclide material, based on the number of samples received. This will allow facility management to determine if the inventory will approach or exceed the LCO limit. Management can then notify the generating facilities that no additional samples will be accepted at the 222-S Laboratory.

7.0 CONCLUSION

The 222-S Laboratory has been classified as a low-hazard nuclear facility in accordance with WHC-CM-4-46 (Bourger 1993a) and categorized as a Category 3 facility in accordance with DOE 1992 (Bourger 1993b). Therefore, applying the graded approach to the assessment of the analyzed safety envelope, it can be concluded that the ISB defines the authorization basis for performing USQ screenings and evaluations in accordance with WHC procedures and DOE Order 5480.21. This conclusion is based on the operations and design of the facility and the revised accident analysis, including the safety equipment list and TSRs.

The facility's conduct of operations has been evaluated with respect to the institutional and safety controls. The evaluation compared the facility-specific procedures to the WHC control manuals that implement the institutional and safety controls established in the DOE orders. Based on the results of the comparative evaluation, it can be concluded that the existing facility procedures adequately implement the WHC control manuals (Appendix A).

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8.0 REFERENCES

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29 CFR 1910, 1992, "Occupational Safety and Health Standards," *Code of Federal Regulation*, as amended.

40 CFR 302, 1992, "Designation, Reportable Quantities, and Notification," *Code of Federal Regulations*, as amended.

40 CFR 355, 1992, "Emergency Planning and Notification," *Code of Federal Regulations*, as amended.

8.3 STATE AND FEDERAL ACTS

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Resource Conservation and Recovery Act of 1976, 42 U.S.C. 6901 et seq.

8.4 U.S. DEPARTMENT OF ENERGY ORDERS

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DOE Order 5820.2A, *Radioactive Waste Management*, U.S. Department of Energy, Washington, D.C.

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8.5 WESTINGHOUSE HANFORD COMPANY CONTROL MANUALS

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WHC-CM-1-2, *Organizations Charts and Charters*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-1-3, *Management Requirements and Procedures*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-1-5, *Standard Operating Practices*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-1-6, *Westinghouse Radiological Control Manual*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-2-1, *Procurement Manual and Procedures*, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX A

CONDUCT OF OPERATIONS COMPARATIVE EVALUATION

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Table A-1. Identification of DOE Orders, WHC Control Manuals and 222-S Laboratory Implementing Documentation. (9 sheets)

Institutional control or safety requirement	DOE order and title	Applicable WHC control manual	222-S Laboratory implementing document(s)
Radiation Protection	5400.5, *Radiation Protection of the Public and the Environment* 5480.4, *Environmental Protection, Safety, and Health Protection Standards*	WHC-CM-1-3, *Management Requirements and Procedures* WHC-CM-4-10, *Radiation Protection* (superseded by WHC-CM-1-6, *WHC Radiological Control Manual*) WHC-CM-4-11, *ALARA Program Manual* WHC-CM-7-5, *Environmental Compliance Manual*	WHC-SD-CP-HSP-001, *Chemical Hygiene Program*, Section 9.0, addresses radiation protection/monitoring within the 222-S Laboratory and specifies that industrial health personnel will perform random audits of the facility and advise management of any unacceptable conditions, e.g, higher than anticipated radiation levels. Releases to the environment are addressed in Section 6.4.5 of WHC-CM-5-4, *Laboratories Administration*. This section requires that all procedures, revisions, or modifications having the potential to exceed permitted standards be reviewed by Environmental Assurance in accordance with WHC-CM-7-5, *Environmental Compliance*. Facility-specific manuals addressing radiation protection that rely on the requirements contained in WHC-CM-4-10 are currently being revised to comply with the requirements contained in WHC-CM-1-6.

Table A-1. Identification of DOE Orders, WHC Control Manuals and 222-S Laboratory Implementing Documentation. (9 sheets)

Institutional control or safety requirement	DOE order and title	Applicable WHC control manual	222-S Laboratory implementing document(s)
ALARA	5480.11, *Radiation Protection for Occupational Workers*	WHC-CM-4-10, *Radiation Protection* (superseded by WHC-CM-1-6, *WHC Radiological Control Manual*) WHC-CM-4-11, *ALARA Program*	WHC-CM-5-4, *Laboratories Administration*, Section 2.2.5, implements WHC-CM-1-3 and WHC-CM-4-11 by establishing ALARA teams for laboratories and defining the charter of these teams. Facility-specific manuals addressing radiation protection that rely on the requirements contained in WHC-CM-4-10 are currently being revised to comply with the requirements contained in WHC-CM-1-6.
Occupational Safety	5483.1A, *Occupational Safety and Health Program for DOE Contractor Employees at Government-Owned Contractor-Operated Facilities*	WHC-CM-1-3, *Management Requirements and Procedures* WHC-CM-4-2, *Quality Assurance Manual* WHC-CM-4-8, *Quality Assurance Instructions* WHC-CM-4-3, *Industrial Safety Manual* WHC-CM-4-40, *Industrial Hygiene Manual*	WHC-CM-5-4, *Laboratories Administration*, Section 2, "Analytical Chemistry Organization Charter," including the 222-S Facility. This charter requires that all work be performed safely and further requires that management take action should safety concerns be identified.

Table A-1. Identification of DOE Orders, WHC Control Manuals and 222-S Laboratory Implementing Documentation. (9 sheets)

Institutional control or safety requirement	DOE order and title	Applicable WHC control manual	222-S Laboratory implementing document(s)
Fire Protection	5480.7A, *Fire Protection*	WHC-CM-1-3, *Management Requirements and Procedures* WHC-CM-4-3, *Industrial Safety Manual* WHC-CM-4-40, *Industrial Hygiene Manual*	WHC-CM-5-4, *Laboratories Administration*, Section 2, "Analytical Chemistry Organization Charter," including the 222-S Facility. This charter requires that all work be performed safely. The facility is designated as an improved risk facility and therefore is subject to biannual reviews and audits.
Industrial Safety	None identified (see Occupational Safety)		
Industrial Hygiene	5480.10, *Contractor Industrial Hygiene Program*	WHC-CM-1-1, *Management Policies* WHC-CM-1-3, *Management Requirements and Procedures* WHC-CM-4-3, *Industrial Safety Manual* WHC-CM-4-40, *Industrial Hygiene Manual*	WHC-SD-CP-HSP-001, *Westinghouse Hanford Company Chemical Hygiene Plan*, R1-A. This document contains facility-specific chemical hygiene procedures (Appendix C-9). These procedures have been developed to comply with the requirements in 29 CFR 1910.1450. This document is based on the requirements established in WHC-CM-1-3 and WHC-CM-4-3. WHC-CM-5-4, *Laboratories Administration*, Section 2, Analytical Chemistry Organization Charter," including the 222-S Facility.

Table A-1. Identification of DOE Orders, WHC Control Manuals and 222-S Laboratory Implementing Documentation. (9 sheets)

Institutional control or safety requirement	DOE order and title	Applicable WHC control manual	222-S Laboratory implementing document(s)
Industrial Hygiene (Cont.)			This charter requires that all work be performed safely and further requires that management take action should safety concerns be identified.
Criticality Safety	5480.5, *Safety of Nuclear Facilities* 5480.24, *Nuclear Criticality Safety*	WHC-CM-4-29, *Nuclear Criticality Safety Manual*	The 222-S Laboratory is classified as an isolated facility, i.e., the fissile material inventory is limited to one-third of a minimum critical mass; therefore, nuclear criticality is not an issue. WHC-CM-5-4, *Laboratories Administration*, Section 3.5, contains the implementing program for the 222-S Laboratory.
Training for Nuclear Facilities	5480.18A, *Accreditation of Performance-Based Training for Category A Reactors and Nuclear Facilities* 5480.20, *Personnel Selection, Qualification, Training, and Staffing Requirements at DOE Reactor and Non-Reactor Nuclear Facilities*	WHC-CM-2-15, *Training Administration Manual* WHC-CM-4-1, *Emergency Plan* WHC-CM-4-43, *Emergency Management Procedures* WHC-CM-4-44, *Emergency Preparedness Administration*	WHC-CM-5-4, *Laboratories Administration*, Section 4.1, describes the OJT program and the qualification and requalification requirements.

Table A-1. Identification of DOE Orders, WHC Control Manuals and 222-S Laboratory Implementing Documentation. (9 sheets)

Institutional control or safety requirement	DOE order and title	Applicable WHC control manual	222-S Laboratory implementing document(s)
Radioactive Waste Management	5820.2A, *Radioactive Waste Management*	WHC-CM-1-1, *Management Policies* WHC-CM-1-3, *Management Requirements and Procedures* WHC-CM-2-14, *Hazardous Material Packaging and Shipping* WHC-CM-4-9, *Radiological Design* WHC-CM-4-11, *ALARA Program Manual* WHC-CM-4-29, *Nuclear Criticality* WHC-CM-5-16, *Solid Waste Management* WHC-CM-7-5, *Environmental Compliance Manual*	WHC-SD-CP-HSP-001, *Chemical Hygiene Program*, Section 17.0, requires that WHC control manuals be followed when handling and disposing of hazardous wastes. This document requires that radioactive wastes be handled in accordance with the requirements contained in WHC-CM-7-5, *Environmental Compliance*. WHC-SD-CP-QAPP-009, *Solid Low-Level Waste Certification Plan for the 222-S Laboratory Complex*, describes the waste handling procedures.
Occurrence Reporting	5000.3B, *Occurrence Reporting and Processing of Operations Information*	WHC-CM-1-3, *Management Requirements and Procedures* WHC-CM-1-5, *Standard Operating Practices* WHC-CM-4-1, *Emergency Plan*	WHC-CM-5-4, *Laboratories Administration*, Section 3.3, identifies the processes followed with respect to corrective actions, occurrence categorization and notification, and occurrence reporting.

Table A-1. Identification of DOE Orders, WHC Control Manuals and 222-S Laboratory Implementing Documentation. (9 sheets)

Institutional control or safety requirement	DOE order and title	Applicable WHC control manual	222-S Laboratory implementing document(s)
Occurrence Reporting (Cont.)		WHC-CM-4-43, *Emergency Management Procedures* WHC-CM-4-44, *Emergency Preparedness Administration*	
Quality Assurance	5700.6C, *Quality Assurance*	WHC-CM-1-1, *Management Policies* WHC-CM-1-2, *Organization Charts and Charters* WHC-CM-1-3, *Management Requirements and Procedures* WHC-CM-2-1, *Procurement Manual and Procedures* WHC-CM-3-5, *Document Control and Records Management Manual*	Quality assurance at the 222-S Laboratory is addressed in the following manuals: WHC-CM-5-4, *Laboratories Administration*, Section 8.0; addresses samples, instrument calibration, and software control systems

Table A-1. Identification of DOE Orders, WHC Control Manuals and 222-S Laboratory Implementing Documentation. (9 sheets)

Institutional control or safety requirement	DOE order and title	Applicable WHC control manual	222-S Laboratory implementing document(s)
Quality Assurance (Cont.)		WHC-CM-4-2, *Quality Assurance Manual* WHC-CM-6-2, *Project Management* WHC-CM-6-12, *Projects Department Procedures*	WHC-CM-5-3, ***Sample Management and Administration***, all sections; the entire manual discusses sample management and is largely based on the QA requirements contained in WHC-CM-4-2.
Configuration Management	4330.4A, *Maintenance Management Program* 5480.21, Unreviewed Safety Questions 5480.22, *Technical Safety Requirements* 5480.23, *Nuclear Safety Analysis Reports*	WHC-CM-1-3, *Management Requirements and Procedures* WHC-CM-4-46, *Nonreactor Facility Safety Analysis Manual* WHC-CM-6-1, *Standard Engineering Practices* WHC-CM-6-32, *Safety Analysis and Regulation Work Procedures*	See discussion in Section 3.3.4.
Conduct of Operations	5480.19, *Conduct of Operations Requirements for DOE Facilities*	WHC-CM-1-1, *Management Policies*	WHC-CM-5-4, ***Laboratories Administration***, all sections; this document discusses the conduct of operations at the 222-S Laboratory. Conduct of operations, with respect to the operations of the laboratory and handling of specific chemicals are also addressed in WHC-SD-CP-HSP-001.

Table A-1. Identification of DOE Orders, WHC Control Manuals and 222-S Laboratory Implementing Documentation. (9 sheets)

Institutional control or safety requirement	DOE order and title	Applicable WHC control manual	222-S Laboratory implementing document(s)
Emergency Planning	5500.2B, *Emergency Categories, Classes, and Notification and Reporting Requirements* 5500.3A, *Planning and Preparedness for Operational Emergencies*	WHC-CM-1-2, *Organizations Charts and Charters* WHC-CM-1-3, *Management Requirements and Procedures* WHC-CM-4-1, *Emergency Plan* WHC-CM-4-43, *Emergency Management Procedures* WHC-CM-4-44, *Emergency Preparedness Administration*	The building emergency plan is contained in WHC-IP-0263-222S, *Building Emergency Plan for 222-S Laboratory Complex*. This document has been prepared in accordance with WHC-CM-4-43 and WHC-CM-4-44.
Environmental Protection	5400.1, *General Environmental Protection Program* 5400.5, *Radiation Protection of the Public and the Environment* 5480.4, *Environmental Protection, Safety, and Health Protection Standards*	WHC-CM-1-2, *Organizations Charts and Charters* WHC-CM-1-3, *Management Requirements and Procedures* WHC-CM-4-2, *Quality Assurance Manual* WHC-CM-4-3, *Industrial Safety Manual*	WHC-SD-CP-HSP-001, *Chemical Hygiene Program*, Section 9.0, addresses environmental monitoring within the 222-S Laboratory and specifies that industrial health personnel will perform random audits of the facility.

Table A-1. Identification of DOE Orders, WHC Control Manuals and 222-S Laboratory Implementing Documentation. (9 sheets)

Institutional control or safety requirement	DOE order and title	Applicable WHC control manual	222-S Laboratory implementing document(s)
Environmental Protection (Cont.)	5484.1, *Environmental Protection, Safety, and Health Protection Information Reporting Requirements*	WHC-CM-4-40, *Industrial Hygiene Manual* WHC-CM-7-5, Environmental Compliance Manual	Releases to the environment are addressed in Section 6.4.5 of WHC-CM-5-4, *Laboratories Administration*. This section requires that all procedures, revisions or modifications having the potential to exceed permitted standards need to be reviewed by Environmental Assurance in accordance with WHC-CM-7-5, *Environmental Compliance*.

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APPENDIX B

ENVIRONMENTAL HAZARD SAFETY CLASSIFICATION CALCULATIONS

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TOXIC MATERIAL EHSC CALCULATION (2 sheets)

COMPONENT/SYSTEM: 222-S Nitric Acid (850 gal [3,200 L]) tank DATE: 9/13/93 Sheet 1 of 2
DRAWING: ______ LOCATION: 222-S

1. MATERIAL FORM

A. Is the toxic material dispersible (i.e., other than a consolidated or stabilized solid)? Dispersible materials include: liquids, sludges, gases, powders, and unconsolidated solids.

[ ] No Stop. Associated items are safety class 3, other criteria permitting.

[X] Yes Proceed.

B. Are only inert gases (e.g., He and Ar) or other environmentally benign gases (e.g., O_2, N_2, CO_2 and CO) present?

[ ] Yes Stop. Items related to these gases are safety class 3, other criteria permitting.

[X] No Proceed.

2. QUANTITY OF MATERIALS RELEASED

A. TOXIC MATERIALS WITH REPORTABLE QUANTITY (RQ) VALUES IN 40 CFR PART 302.

Category[1]	Amount Released		Multiplier[2]		
X	______	pounds	* 1	=	______
A	______	pounds	* 1/10	=	______
B	______	pounds	* 1/100	=	______
C	9786	pounds	* 1/1000	=	9.786
D	______	pounds	* 1/5000	=	______
			SUM of above	=	9.786

Multiplying Factor (MF) 2.A. = SUM * 10 = 9.786 * 10 = 97.86

B. TOXIC MATERIALS OF REGULATORY/ENVIRONMENTAL CONCERN AND NOT LISTED IN 40 CFR PART 302.

NOTE: This is not an all inclusive list of toxic materials that are not listed in 40 CFR Part 302. Individual materials may need to be evaluated to assess their environmental hazard. Contact the Environmental Engineering or Assurance organization for assistance.

MORE ENVIRONMENTAL HAZARD CATEGORY

- Compounds known to be highly environmentally persistent based on biodegradability
- Metals
- Polycyclic compounds (contain multiple benzene-type rings)
- Halogenated hydrocarbons
- Environmental pathogens (virus or bacteria), engineered organisms, and recombinant DNAs

QUANTITY (MORE)[3]= ______ gal[4]

≤100 gal ... MF=10
>100-1,000 gal ... MF=20
>1,000-10,000 gal ... MF=50
>10,000 gal ... MF=100 MF(MORE)= ______

LESS ENVIRONMENTAL HAZARD CATEGORY

- Compounds known to be somewhat environmentally persistent based on biodegradability
- Petroleum products
- Paints and solvents
- Pesticides, herbicides and fungicides

QUANTITY (LESS)= 850 gal

≤100 gal ... MF=1
>100-1,000 gal ... MF=2
>1,000-10,000 gal ... MF=5
>10,000 gal ... MF=10 MF(LESS)= 2

MF(2.B.) = MF(MORE) + MF(LESS) = 0 + 2 = 2

TOXIC MATERIAL EHSC CALCULATION (2 sheets)	
COMPONENT/SYSTEM: 222-S Nitric Acid (850 gal [3,200 L]) tank DATE: 9/13/93 Sheet 2 of 2 DRAWING: LOCATION: 222-S	
3. TOTAL QUANTITY OF MATERIAL RELEASED[5] = 850 gal	MF(3.)= 5
≤100 gal .... MF=1 >1,000-10,000 gal ... MF=10 100-1,000 gal ... MF=5 ≥10,000 gal .... MF=100	
4. PROXIMITY TO ENVIRONMENTAL RECEIVERS	
A. DEPTH TO AQUIFER = 180-310 feet	MF(4.A)= 1
>150 feet .... MF=1 21-75 feet ...... MF=5 76-150 feet .... MF=2 0-20 feet .... MF=10	
B. DISTANCE TO SENSITIVE SURFACE WATER[6] = 5 miles	MF(4.B)= 1
>2 miles .... MF=1 >500-1000 feet ... MF=16 >1.5-2 miles .... MF=3 100-500 feet ..... MF=20 >2500 feet - 1.5 miles ... MF=6 <100 feet .... MF=25 >1000-2500 feet .... MF=9 Direct discharge to surface water ... MF=50	
C. DISTANCE TO OFFSITE BOUNDARY = 9.0 (14.4 km) miles	MF(4.C)= 2
>10 miles .... MF=1 >3-6 miles ...... MF=5 >6-10 miles .... MF=2 0-3 miles .... MF=10	
5. CARCINOGENICITY MODIFYING FACTOR	MF(5)= 1
EPA CARCINOGEN CLASSIFICATION[7] A, B ... MF=2 C, D ... MF=1	
6. CALCULATION OF ENVIRONMENTAL IMPACT FOR SAFETY CLASSIFICATION The EHSC is determined as follows where each term is the multiplying factor (MF) from the respective paragraphs above. Based on the chemicals involved, the multiplying factors for terms 2.A or 2.B and term 5. may not apply. Terms 4.A, 4.B, and/or 4.C are applied where legitimate pathways to the environment exist. EHSC = (2.A+2.B)(3.)(4.A)(4.B)(4.C)(5) =	
EHSC = (97.86+2)(5)(1)(1)(2)(1)=1000	

[1] From 40 CFR Part 302.

[2] Denominator is final RQ in pounds for the given category.

[3] Quantity is that amount of each toxic material postulated to be released to the environment.

[4] 1 gallon = 3.785 liters, 1 gallon = 8.34 lbs (at 4°C, a specific gravity of 1, and atmospheric pressure)

[5] The total quantity of toxic material postulated to be released to the environment.

[6] Examples of sensitive surface waters are the Columbia River and West Lake.

[7] The EPA carcinogen classification is acquired from the IRIS database.

RADIOACTIVE MATERIAL EHSC CALCULATION (2 sheets)

COMPONENT/SYSTEM: 219-S Waste Handling DATE: 9/13/93 Sheet 1 of 2
DRAWING: LOCATION: 222-S

1. MATERIAL FORM

Is the radioactive material dispersible (i.e., other than a consolidated or stabilized solid)? Dispersible materials include: liquids, sludges, gases, powders, and unconsolidated solids.

[ ] No Stop. Associated items are safety class 3, other criteria permitting.

[X] Yes Proceed.

2. QUANTITY OF MATERIALS RELEASED MF(2.)=110

The following matrix provides multiplying factors which are a function of the total estimated curie content postulated to be released to the environment from the system(s), component(s), and/or structure(s) of interest.

Group radioisotopes by half-life ($T_{½}$) category and show total amount (in Curies [Ci]) for each category:

$T_{½}$<1 yr: Amount = ______ Ci $T_{½}$=1 to 100 yrs: Amount = 2.776 Ci

$T_{½}$>100 yrs: Amount = 0.01246 Ci

Mark the applicable multiplying factors below.

	Half-life		
Amount (Ci)	≤1 yr.[1]	1-100 yrs.	>100 yrs.
<1	MF=1	MF=10	MF=100
1-1000	MF=10	MF=100	MF=1,000
>1000-10^5	MF=100	MF=1,000	MF=10,000
>10^5	MF=1,000	MF=10,000	MF=100,000

MF(2.) = SUM of circled MFs = 200

3. TOTAL QUANTITY OF MATERIAL RELEASED[2] = 9,500 gal MF(3.)= 10

≤100 gal .... MF=1
>100-1,000 gal ... MF=5
>1,000-10,000 gal ... MF=10
≥10,000 gal .... MF=100

4. PROXIMITY TO ENVIRONMENTAL RECEIVERS

A. DEPTH TO AQUIFER = 180-310 feet MF(4.A)= 1

>50 feet .... MF=1
76-150 feet .... MF=2
21-75 feet .... MF=5
0-20 feet .... MF=10

B. DISTANCE TO SENSITIVE SURFACE WATER[4][5] = 26,400 feet MF(4.B)= NA

>2500 feet .... NA
>1000-2500 feet ..... MF=9
>500-1000 feet ...... MF=16
100-500 feet ..... MF=20
<100 feet .... MF=25
Direct discharge to surface water ... MF=50

C. DISTANCE TO OFFSITE BOUNDARY[5] = 47,520 feet MF(4.C)= NA

>2500 feet ... NA 1000-2500 feet ... MF=5 <1000 feet ... MF=10

RADIOACTIVE MATERIAL EHSC CALCULATION (2 sheets)		
COMPONENT/SYSTEM: 219-S Waste Handling DRAWING:	DATE: 9/13/93 LOCATION: 222-S	Sheet 2 of 2
5. CALCULATION OF ENVIRONMENTAL IMPACT FOR SAFETY CLASSIFICATION The EHSC is determined as follows where each term is the multiplying factor (MF) from the respective paragraphs above. Terms 4.A, 4.B, and/or 4.C are applied where legitimate pathways to the environment exist. EHSC = (2.)(3.)(4.A)(4.B)(4.C) =		
EHSC =(200)(10)(1)(NA)(NA)=2,000		

[1]Tritium is included in this category as an exception.

[2]Total quantity of radioactive material postulated to be released to the environment.

[3]1 gallon = 3.785 liters, 1 gallon = 8.34 lbs (at 4 °C, a specific gravity of 1, and atmospheric pressure).

[4]Examples of sensitive surface waters are the Columbia River and West Lake.

[5]Airborne pathways do not apply for this sensitive surface water or offsite boundary criterion (Table 1, criterion 12).

APPENDIX C

DOSE CONSEQUENCE CALCULATIONS

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Westinghouse Hanford Company **Internal Memo**

From: Restoration & Remediation Safety Analysis FHB-29540-93-004
Phone: 376-8564 H4-68
Date: September 30, 1993
Subject: DOSE CONSEQUENCE ANALYSIS IN SUPPORT OF 222-S LABORATORY

To: R&RSA 222-S File H4-68

cc: E. E. Leitz H4-68 EEL
J. C. Lavender H4-70
FHB File/LB

A radiological dose consequence analysis for a postulated fire in the 222-SC filter building has been performed to support the safety analysis for the 222-S Laboratory. Doses were calculated for the onsite receptor at 900 m NNW, and the offsite receptor at 13.5km W using GENII Version 1.485. A description of the accident source term and the results of this analysis are provided in the attached.

Fred H Bourger

F. H. Bourger
Engineer

siw

Attachment

DOSE CONSEQUENCES IN SUPPORT OF SAFETY ANALYSIS FOR 222- LABORATORY

1.0 Purpose

The purpose of this report is to calculate the potential dose consequences for a postulated fire of a HEPA filter building as described in Section 2.0. This analysis will use all transport assumptions, onsite and offsite receptor locations and directions as previously used and called out in a report preformed by L. V. Nguyen to support 222-S safety analysis. The accident has been evaluated as a ground level release for the maximum onsite receptor at 900m NNW (nearest occupied facility), and the offsite receptor at 13.5km W. The dose calculations from the postulated accident have been calculated using the GENII computer code Version 1.485.

2.0 Accident Scenario

The accident evaluated in this analysis is a fire within the 222-SC Filter Building. Although there may be many possible initiators for this type of accident, one may occur from a truck travelling faster than recommended and attempt to avoid a pedestrian, then slam into the 222-SC Filter House. The truck can break through the walls, leak gasoline from a torn gas line or ruptured gas tank and spread gasoline about and into the premises. Ignition may result from hot contact surfaces or a broken electrical line, with the fuel from the vehicle providing the initial combustion fuel.

3.0 Source Term

The source term is based on the discharged exhaust from 296-S-21 Stack which is continuously sampled and periodically analyzed. Emissions reported for Calendar Year 1989 were reported as <3.33E-06 Ci for gross alpha and 1.78E-05 Ci for gross beta, see Table B-2 (WHC-EP-0141-2). Application of the multiplication factor (1/(1-efficiency), where HEPA efficiency is 99.97%) of 3333 to simulate loss of HEPA filtration gives an estimated release (over a 20 yr period) of 0.24 Ci for gross alpha and 1.18 Ci for gross beta. Based on the estimated facility inventory provided in the Hazard Categorization for the 222-S Laboratory, the major alpha and beta contributors were determined to be Pu239 and Sr90, respectively. Table 4-1 provides the source term of Pu239 and Sr90 that would be released from a fire.

Table 4-1 HEPA Filter Fire Source Term

Radionuclide	Inventory (Ci)	Release Fraction	Source term (Ci)
Pu239	0.24	1.0E-04	2.4E-05
Sr90	1.18	1.0E-04	1.2E-04

4.0 Release Fraction

The release fraction has been based on experimental data from the burning of both unused and removed from service HEPA filters due to high differential pressures (clogged) (J. Mishima 1993). The HEPA filters were tested using solid particles at a range of temperatures less than required for failure. Based on this data the airborne release fraction/respirable fraction value for the impact of heat upon loaded HEPA filters of 1.0E-04/1.0 was recommended.

5.0 Code Documentation

GENII Version 1.485
GENII Default Parameter Values (28-Mar-90 RAP)
Radionuclide Master Library (11/15/90 PDR)
External Dose Factors for GENII in person Sv/yr per Bq/n (8-May-90 R)
Internal Dose Increments, Worst Case Solubilities, 12/3/90 PDR
Joint Frequency Data, 200 Area, 10m, Pasquill A-F (1983-1987 Average)

6.0 Results

To determine the potential dose to the onsite and offsite receptors, both submersion and inhalation doses were considered. The doses provided in Table 6-1 were calculated using 95 percentile meteorology to both receptors for an acute ground level release. The GENII input/output files for the onsite receptor are attached for reference.

Table 6-1 Results of Hepa Filter Fire

Receptor	Dose Type	EDE (Rem)	Limiting Organ (Rem)
Onsite (900 m)	Inhalation	2.6E-03	4.7E-02 (Bone Sur)
	Submersion	1.4E-10	1.4E-10
	Total	2.6E-03	4.7E-02 (Bone Sur)
Offsite (13.5 km)	Inhalation	5.7E-05	1.0E-03 (Bone Sur)
	Submersion	2.9E-12	2.9E-12
	Total	5.7E-05	1.0E-03 (Bone Sur)

7.0 References

B.A. Napier, Et Al., GENII - The Hanford Environmental Radiation Dosimetry Software System, PNL-6484, Dec 1988.

J. Mishima, (DRAFT) Recommended Values and Technical Bases for Airborne Release Fractions (ARFs), Airborne Release Rates (ARRs), and Respirable Fractions (RFs) for Materials from Accidents in DOE Fuel Cycle, Ex-Reactor Facilities (1993)

WHC-EP-0141-2, Westinghouse Hanford Company Effluent Discharges and Solid Waste Management Report for calendar Year 1989: 200/600 Areas

WHC-SD-WM-HC-008, Rev 0, Hazard Categorization Report for the 222-S Laboratory, Westinghouse Hanford Company, Richland, Washington

```
######################### Program GENII Input File ############  8 Jul 88 ####
Title: Onsite Dose due to filter fire 222-S laboratory
     \GENII\filter2.in                          Created on 09-29-1993 at 18:14
^^TIONS======================= Default ===================================
     Near-field scenario?        (Far-field)   NEAR-FIELD: narrowly-focused
,    Population dose?           (Individual)               release, single site
T    Acute release?               (Chronic)    FAR-FIELD:  wide-scale release,
     Maximum Individual data set used                      multiple sites
                                 Complete                                 Complete
TRANSPORT OPTIONS=========== Section    EXPOSURE PATHWAY OPTIONS===== Section
T  Air Transport                   1       F  Finite plume, external        5
F  Surface Water Transport         2       T  Infinite plume, external      5
F  Biotic Transport (near-field)   3,4     F  Ground, external              5
F  Waste Form Degradation (near)   3,4     F  Recreation, external          5
                                           T  Inhalation uptake             5,6
REPORT OPTIONS=====================        F  Drinking water ingestion      7,8
T  Report AEDE only                        F  Aquatic foods ingestion       7,8
T  Report by radionuclide                  F  Terrestrial foods ingestion   7,9
T  Report by exposure pathway              F  Animal product ingestion      7,10
F  Debug report on screen                  F  Inadvertent soil ingestion

INVENTORY ##################################################################

 4    Inventory input activity units: (1-pCi  2-uCi  3-mCi  4-Ci  5-Bq)
 0    Surface soil source units (1- m2  2- m3  3- kg)
      Equilibrium question goes here

      --------|----Release Terms------|----------Basic Concentrations---------|
      Use when| transport selected    | near-field scenario, optionally       |
      --------|-----------------------|---------------------------------------|
      Release |       Surface Buried  |       Surface Deep    Ground  Surface |
      Radio-  |Air    Water   Waste   |Air    Soil    Soil    Water   Water   |
      nuclide |/yr    /yr     /m3     |/m3    /unit   /m3     /L      /L      |
      --------|------- ------- -------|------- ------- ------- ------- -------|
      SR90     1.2E-04
      Y 90     1.2E-04
      PU239    2.4E-05

      --------|----Derived Concentrations-----|
      Use when|  measured values are known    |
      --------|-------------------------------|
      Release |Terres. Animal  Drink   Aquatic|
      Radio-  |Plant   Product Water   Food   |
      nuclide |/kg     /kg     /L      /kg    |
      --------|------- ------- ------- -------|

TIME #######################################################################

1     Intake ends after (yr)
50    Dose calc. ends after (yr)
0     Release ends after (yr)
0     No. of years of air deposition prior to the intake period
0     No. of years of irrigation water deposition prior to the intake period

   -FIELD SCENARIOS (IF POPULATION DOSE) ##################################

0          Definition option: 1-Use population grid in file POP.IN
0                             2-Use total entered on this line
```

```
NEAR-FIELD SCENARIOS ##################################################################

          Prior to the beginning of the intake period: (yr)
            When was the inventory disposed?  (Package degradation starts)
            When was LOIC?  (Biotic transport starts)
0         Fraction of roots in upper soil (top 15 cm)
0         Fraction of roots in deep soil
0         Manual redistribution: deep soil/surface soil dilution factor
0         Source area for external dose modification factor (m2)
TRANSPORT ############################################################################
          ====AIR TRANSPORT=====================================SECTION 1=====
                  0-Calculate PM              |0         Release type (0-3)
3         Option: 1-Use chi/Q or PM value     |F         Stack release (T/F)
                  2-Select MI dist & dir      |0         Stack height (m)
                  3-Specify MI dist & dir     |0         Stack flow (m3/sec)
0         Chi/Q or PM value                   |0         Stack radius (m)
8         MI sector index (1=S)               |0         Effluent temp. (C)
900.0     MI distance from release point (m)|0         Building x-section (m2)
T         Use jf data, (T/F) else chi/Q grid|0         Building height (m)

          ====SURFACE WATER TRANSPORT===========================SECTION 2=====
0         Mixing ratio model: 0-use value, 1-river, 2-lake
0         Mixing ratio, dimensionless
0         Average river flow rate for: MIXFLG=0 (m3/s), MIXFLG=1,2 (m/s),
0         Transit time to irrigation withdrawl location (hr)
          If mixing ratio model > 0:
0           Rate of effluent discharge to receiving water body (m3/s)
0           Longshore distance from release point to usage location (m)
            Offshore distance to the water intake (m)
            Average water depth in surface water body (m)
0           Average river width (m), MIXFLG=1 only
0           Depth of effluent discharge point to surface water (m), lake only

          ====WASTE FORM AVAILABILITY===========================SECTION 3=====
0         Waste form/package half life, (yr)
0         Waste thickness, (m)
0         Depth of soil overburden, m

          ====BIOTIC TRANSPORT OF BURIED SOURCE=================SECTION 4=====
T         Consider during inventory decay/buildup period (T/F)?
T         Consider during intake period (T/F)?    | 1-Arid non agricultural
0         Pre-Intake site condition..............| 2-Humid non agricultural
                                                  | 3-Agricultural

EXPOSURE #############################################################################

          ====EXTERNAL EXPOSURE=================================SECTION 5=====
          Exposure time:                    |   Residential irrigation:
0           Plume (hr)                      | T        Consider: (T/F)
0           Soil contamination (hr)         | 0        Source: 1-ground water
0           Swimming (hr)                   |                  2-surface water
0           Boating (hr)                    | 0        Application rate (in/yr)
0           Shoreline activities (hr)       | 0        Duration (mo/yr)
          Shoreline type: (1-river, 2-lake, 3-ocean, 4-tidal basin)
          Transit time for release to reach aquatic recreation (hr)
1.0       Average fraction of time submersed in acute cloud (hr/person hr)
```

```
          ====INHALATION=======================================SECTION 6=====
8766.0    Hours of exposure to contamination per year
0         0-No resus-  1-Use Mass Loading            2-Use Anspaugh model
            pension      Mass loading factor (g/m3)   Top soil available (cm)

          ====INGESTION POPULATION=============================SECTION 7=====
0         Atmospheric production definition (select option):
0           0-Use food-weighted chi/Q, (food-sec/m3), enter value on this line
            1-Use population-weighted chi/Q
            2-Use uniform production
            3-Use chi/Q and production grids (PRODUCTION will be overridden)
0         Population ingesting aquatic foods, 0 defaults to total (person)
0         Population ingesting drinking water, 0 defaults to total (person)
F         Consider dose from food exported out of region (default=F)

          Note below: S* or Source: 0-none, 1-ground water, 2-surface water
                                    3-Derived concentration entered above
          ==== AQUATIC FOODS / DRINKING WATER INGESTION=========SECTION 8====

F         Salt water? (default is fresh)

          USE         TRAN-  PROD-    -CONSUMPTION- |
          ?   FOOD    SIT    UCTION   HOLDUP   RATE |
          T/F TYPE    hr     kg/yr    da      kg/yr |       DRINKING WATER
          --- ------  -----  -------  ------  ----- |------------------------
          F   FISH     0.00  0.0E+00   0.00    0.0  | 0      Source (see above)
          F   MOLLUS   0.00  0.0E+00   0.00    0.0  | T      Treatment? T/F
          F   CRUSTA   0.00  0.0E+00   0.00    0.0  | 0      Holdup/transit(da)
          F   PLANTS   0.00  0.0E+00   0.00    0.0  | 0      Consumption (L/yr)

          ====TERRESTRIAL FOOD INGESTION=======================SECTION 9=====

          USE         GROW   --IRRIGATION--             PROD-    --CONSUMPTION--
          ?   FOOD    TIME   S RATE   TIME    YIELD     UCTION   HOLDUP   RATE
          T/F TYPE    da     * in/yr  mo/yr   kg/m2     kg/yr    da       kg/yr
          --- ------  -----  - -----  -----   -----     -------  ------   ------
          F   LEAF V  0.00   0   0.0   0.0      0.0     0.0E+00    0.0      0.0
          F   ROOT V  0.00   0   0.0   0.0      0.0     0.0E+00    0.0      0.0
          F   FRUIT   0.00   0   0.0   0.0      0.0     0.0E+00    0.0      0.0
          F   GRAIN   0.00   0   0.0   0.0      0.0     0.0E+00    0.0      0.0

          ====ANIMAL PRODUCTION CONSUMPTION=====================SECTION 10====

          ---HUMAN---- TOTAL   DRINK    -------------STORED FEED--------------
USE       CONSUMPTION  PROD-   WATER    DIET   GROW  -IRRIGATION--          STOR-
?   FOOD  RATE  HOLDUP UCTION  CONTAM   FRAC-  TIME  S RATE  TIME    YIELD  AGE
T/F TYPE  kg/yr  da    kg/yr   FRACT.   TION   da    * in/yr mo/yr   kg/m3  da
--- ------ ------ ----- ------ -------  ----   ----  - ----- -----   -----  -----
F   BEEF    0.0   0.0   0.00    0.00    0.00   0.0   0   0.0  0.00    0.00   0.0
F   POULTR  0.0   0.0   0.00    0.00    0.00   0.0   0   0.0  0.00    0.00   0.0
F   MILK    0.0   0.0   0.00    0.00    0.00   0.0   0   0.0  0.00    0.00   0.0
F   EGG     0.0   0.0   0.00    0.00    0.00   0.0   0   0.0  0.00    0.00   0.0
                                        -------------FRESH FORAGE------------
    BEEF                                0.00   0.0   0   0.0  0.00    0.00   0.0
    MILK                                0.00   0.0   0   0.0  0.00    0.00   0.0

##############################################################################
```

GENII Dose Calculation Program
(Version 1.485 3-Dec-90)

e title: Onsite Dose due to filter fire 222-S laboratory

cuted on: 09/29/93 at 18:14:44 Page A. 1

This is a far-field (wide-scale release, multiple site) scenario.
Release is acute
Individual dose

THE FOLLOWING TRANSPORT MODES ARE CONSIDERED
Air

THE FOLLOWING EXPOSURE PATHS ARE CONSIDERED:
Infinite plume, external
Inhalation uptake

THE FOLLOWING TIMES ARE USED:
Intake ends after (yr): 1.0
Dose calculations ends after (yr): 50.0

========== FILENAMES AND TITLES OF FILES/LIBRARIES USED ==========

Input file name: \GENII\filter2.in
GENII Default Parameter Values (28-Mar-90 RAP)
-dionuclide Master Library (11/15/90 PDR)
ernal Dose Factors for GENII in person Sv/yr per Bq/n (8-May-90 R
...cernal Dose Increments, Worst Case Solubilities, 12/3/90 PDR
? AREA - 10 M - Pasquill A - F (1983 - 1987 Average)

--------	----Release Terms------		
Release Radio- nuclide	Air Ci/yr	Surface Water Ci/yr	Buried Source Ci/m3
SR90	1.2E-04	0.0E+00	0.0E+00
Y 90	1.2E-04	0.0E+00	0.0E+00
PU239	2.4E-05	0.0E+00	0.0E+00

========== AIR TRANSPORT ==========

Joint frequency data input.
9.0E+02 Maximum individual distance from release point (m)
8.0E+00 Maximum individual sector index (Wind Toward NNW)
Ground level release.

========== EXTERNAL EXPOSURE ==========

1.0E+00 Fraction of time spent in cloud

========== INHALATION ==========

Resuspension not considered

GENII Dose Calculation Program
(Version 1.485 3-Dec-90)

..se title: Onsite Dose due to filter fire 222-S laboratory

Executed on: 09/29/93 at 18:14:44 Page A. 2

	Probability	E/Q (sec/m3)	DOQ (m2)	Travel Time (sec)	Population-Weighted E/Q (person-sec/m3)
Sector index: 8					
Distance: 900.0					
	0.0353	8.3E-04	8.3E-06	1011.	
	0.0500	7.4E-04	7.4E-06	1011.	
	0.1000	4.6E-04	4.6E-06	1011.	
	0.2500	2.5E-04	2.5E-06	340.	
	0.5000	1.3E-04	1.3E-06	191.	

GENII Dose Calculation Program
(Version 1.485 3-Dec-90)

Case title: Onsite Dose due to filter fire 222-S laboratory

-ecuted on: 09/29/93 at 18:14:52 Page B. 1

,.4E-04 Individual E/Q

Acute release
Uptake/exposure period: 1.0
Dose commitment period: 50.0
Dose units: Rem

Organ	Committed Dose Equivalent	Weighting Factors	Weighted Dose Equivalent
Gonads	6.5E-04	2.5E-01	1.6E-04
Breast	5.4E-08	1.5E-01	8.1E-09
R Marrow	3.7E-03	1.2E-01	4.4E-04
Lung	3.5E-04	1.2E-01	4.2E-05
Thyroid	5.5E-08	3.0E-02	1.7E-09
Bone Sur	4.7E-02	3.0E-02	1.4E-03
Liver	8.2E-03	6.0E-02	4.9E-04
LL Int.	2.3E-06	6.0E-02	1.4E-07
UL Int.	8.8E-07	6.0E-02	5.3E-08
S Int.	2.1E-07	6.0E-02	1.3E-08
Stomach	1.2E-07	6.0E-02	7.1E-09
Internal Effective Dose Equivalent			2.6E-03
External Dose			1.4E-10

```
---------------------------------------------
Annual Effective Dose Equivalent      2.6E-03


---------------------------------------------
Controlling Organ:                    Bone Sur
Controlling Pathways:                 Inh
Controlling Radionuclide:             PU239
---------------------------------------------
Total Inhalation EDE:                 2.6E-03
Total Ingestion EDE:                  0.0E+00
---------------------------------------------

------------------------------------------------------------------------------
                      GENII  Dose Calculation Program
                        (Version 1.485 3-Dec-90)

Case title:   Onsite Dose due to filter fire 222-S laboratory

Executed on:  09/29/93 at 18:15:01                                 Page C.  2
------------------------------------------------------------------------------

Acute release
Uptake/exposure period:                                        1.0
Dose commitment period:                                        50.0
Dose units:                                                Rem



            Dose Commitment Year
                 1         2         3      ...
             _________________________________
Internal   : |
Intake     : |
Year:      3 |                    0.0E+00   ...
             |                       +
           2 |          0.0E+00   0.0E+00   ...             Internal
             |             +         +                      Effective
           1 | 1.1E-04 + 7.5E-05 + 7.3E-05 + ...  =  2.6E-03  Dose
                                                            Equivalent
                  ||        ||        ||
Internal                                                    Cumulative
Annual           1.1E-04 + 7.5E-05 + 7.3E-05 + ...  =  2.6E-03  Internal
Dose                                                        Dose
                   +         +         +                +
External
Annual           1.4E-10   0.0E+00   0.0E+00   ...     1.4E-10
Dose
                  ||        ||        ||               ||
Annual                                                      Cumulative
Dose             1.1E-04 + 7.5E-05 + 7.3E-05 + ...  =  2.6E-03  Dose

                                                            Maximum
                                                       1.1E-04  Annual
                                                            Dose Occurred
                                                            In Year  1
```

GENII Dose Calculation Program
(Version 1.485 3-Dec-90)

Case title: Onsite Dose due to filter fire 222-S laboratory

Executed on: 09/29/93 at 18:15:01 Page C. 3

Acute release
Uptake/exposure period: 1.0
Dose commitment period: 50.0
Dose units: Rem

Committed Dose Equivalent by Exposure Pathway

Pathway	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
Inhale	3.5E-04	1.2E-07	2.1E-07	8.8E-07	2.3E-06	4.7E-02	3.7E-03	6.5E-04
Total	3.5E-04	1.2E-07	2.1E-07	8.8E-07	2.3E-06	4.7E-02	3.7E-03	6.5E-04

Pathway	Ovaries	Muscle	Thyroid	Liver
ʼale	6.5E-04	5.4E-08	5.5E-08	8.2E-03
ıotal	6.5E-04	5.4E-08	5.5E-08	8.2E-03

External Dose by Exposure Pathway

Pathway	
Plume	1.4E-10
Total	1.4E-10

GENII Dose Calculation Program
(Version 1.485 3-Dec-90)

se title: Onsite Dose due to filter fire 222-S laboratory

Executed on: 09/29/93 at 18:15:01 Page C. 4

Acute release
Uptake/exposure period: 1.0
Dose commitment period: 50.0
Dose units: Rem

Committed Dose Equivalent by Radionuclide

Radionuclide	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
SR 90	1.5E-07	3.9E-08	4.2E-08	1.0E-07	3.3E-07	7.0E-05	3.1E-05	3.5E-08
Y 90	1.0E-06	4.7E-08	1.2E-07	5.7E-07	1.4E-06	1.7E-09	1.7E-09	5.8E-11
PU 239	3.5E-04	3.3E-08	5.2E-08	2.1E-07	6.1E-07	4.7E-02	3.7E-03	6.5E-04
Total	3.5E-04	1.2E-07	2.1E-07	8.8E-07	2.3E-06	4.7E-02	3.7E-03	6.5E-04

Radionuclide	Ovaries	Muscle	Thyroid	Liver
SR 90	3.5E-08	3.4E-08	3.5E-08	0.0E+00
Y 90	5.7E-11	5.6E-11	5.7E-11	1.7E-09
239	6.5E-04	2.0E-08	2.0E-08	8.2E-03
T 1	6.5E-04	5.4E-08	5.5E-08	8.2E-03

Acute release
Uptake/exposure period: 1.0
Dose commitment period: 50.0
Dose units: Rem

Radio-nuclide	Inhalation Effective Dose Equivalent	Ingestion Effective Dose Equivalent	External Dose	Internal Effective Dose Equivalent	Annual Effective Dose Equivalent
SR 90	5.9E-06	0.0E+00	3.6E-12	5.9E-06	5.9E-06
Y 90	2.5E-07	0.0E+00	1.3E-10	2.5E-07	2.5E-07
PU 239	2.6E-03	0.0E+00	3.8E-13	2.6E-03	2.6E-03

PEER REVIEW CHECKLIST

Document Reviewed: 9/30/93 FHB-29540-93-004
Author: F. H. Bourger
Date: 10/1/93
Scope of Review: Entire Document

Yes	No	NA	
[ ]	[ ]	[X]	Previous reviews complete and cover analysis, up to scope of this review, with no gaps.
[X]	[ ]	[ ]	Problem completely defined.
[X]	[ ]	[ ]	Accident scenarios developed in a clear and logical manner.
[X]	[ ]	[ ]	Necessary assumptions explicitly stated and supported.
[X]	[ ]	[ ]	Computer codes and data files documented.
[X]	[ ]	[ ]	Data used in calculations explicitly stated in document.
[X]	[ ]	[ ]	Data checked for consistency with original source information as applicable.
[X]	[ ]	[ ]	Mathematical derivations checked including dimensional consistency of results.
[X]	[ ]	[ ]	Models appropriate and used within range of validity or use outside range of established validity justified.
[X]	[ ]	[ ]	Hand calculations checked for errors. Spreadsheet results should be treated exactly the same as hand calculations.
[X]	[ ]	[ ]	Software input correct and consistent with document reviewed.
[X]	[ ]	[ ]	Software output consistent with input and with results reported in document reviewed.
[ ]	[ ]	[X]	Limits/criteria/guidelines applied to analysis results are appropriate and referenced. Limits/criteria/guidelines checked against references.
[ ]	[ ]	[X]	Safety margins consistent with good engineering practices.
[X]	[ ]	[ ]	Conclusions consistent with analytical results and applicable limits.
]	[ ]	[ ]	Results and conclusions address all points required in the problem statement.
]	[ ]	[X]	Format consistent with appropriate NRC Regulatory Guide or other standards
[ ]	[ ]	[X]	Review calculations, comments, and/or notes are attached.
[X]	[ ]	[ ]	Document approved.

Brit Hey [signature] 10/1/93
Reviewer (Printed Name and Signature) Date

[ ] [ ] [ ] Analysis entered into analysis database

(Printed Name and Signature) Date

HEDOP REVIEW CHECKLIST
for
Radiological and Nonradiological Release Calculations

Document reviewed (include title or description of calculation, document number, author, and date, as applicable):

Dose Consequence Analysis in Support of 222-S Laboratory, F.H Bourger, 9/30/93, FHB-29540-93-004

Submitted by: F.H. Bourger Date Submitted: 10/1/93

Scope of Review: entire document

YES	NO*	N/A		
[X]	[ ]	[ ]	1.	A detailed technical review and approval of the environmental transport and dose calculation portion of the analysis has been performed and documented.
[X]	[ ]	[ ]	2.	Detailed technical review(s) and approval(s) of scenario and release determinations have been performed and documented.
[X]	[ ]	[ ]	3.	HEDOP-approved code(s) were used.
[ ]	[ ]	[X]	4.	Receptor locations were selected according to HEDOP recommendations.
[X]	[ ]	[ ]	5.	All applicable environmental pathways and code options were included and are appropriate for the calculations.
[X]	[ ]	[ ]	6.	Hanford site data were used.
[ ]	[ ]	[X]	7.	Model adjustments external to the computer program were justified and performed correctly.
[X]	[ ]	[ ]	8.	The analysis is consistent with HEDOP recommendations.
[ ]		[X]	9.	Supporting notes, calculations, comments, comment resolutions, or other information is attached. (Use the "Page 1 of X" page numbering format and sign and date each added page.)
[X]	[ ]		10.	**Approval is granted on behalf of the Hanford Environmental Dose Overview Panel.**

* All "NO" responses must be explained and use of nonstandard methods justified.

D.A. Himes [signature] 10/1/93
HEDOP-Approved Reviewer (Printed Name and Signature) Date

COMMENTS (add additional signed and dated pages if necessary):

Westinghouse Hanford Company **Internal Memo**

From: Radiological & Toxicological Analysis 29250-LVN-93020
Phone: 376-9710 H4-64
Date: October 19, 1993
Subject: GENII DOSE CONSEQUENCE CALCULATIONS IN SUPPORT OF SAFETY ANALYSIS FOR THE 222-S LABORATORY

To: E. E. Leitz H4-68

cc:	F. H. Bourger	H4-68
	J. S. Davis	H4-64
	B. E. Hey	H4-64
	D. A. Himes	H4-64
	L. E. Johnson	H4-70
	J. C. Lavender	H4-70
	J. C. Van Keuren	H4-64
	LVN File/LB	

Radiological dose consequences and toxicological consequences analyses for the 222-S Laboratory have been completed as requested. Doses and concentrations were calculated for seven scenarios that included radiological and toxicological releases of isotopes and nitric acid spills from several tanks located in the 222-S Laboratory. The computer codes applied in the reports are the GENII version 1.485, Microshield Version 3.12, and ARCHIE computer code. The source terms were specified by the customer. The results are reported in the attachment.

If you have any questions, feel free to call me on 376-9710.

Locnguyen

Loc V. Nguyen
Engineer

Concurrence: J C Van Keuren 10/19/93
J. C. Van Keuren, Manager Date
Radiological & Toxicological Analysis

Attachment

GENII DOSE CONSEQUENCE CALCULATIONS IN SUPPORT OF THE SAFETY ANALYSIS FOR THE 222 LABORATORY

L. V. Nguyen
October 19, 1993

PURPOSE

Potential dose consequences to the maximum onsite receptor at 900 m, and offsite receptor at 13.5 km from several postulated accidents involving several locations in the 200 West Area have been calculated using the GENII computer code Version 1.485 (Napier et al. 1988). The exposure to a facility worker from gamma-rays was calculated using the Microshield computer code Version 3.12 (Negin and Worku 1982). The potential concentration consequences to the maximum onsite receptor at 900 m and offsite receptor at 13.5 km from spills of 378.5 L (100 gal) and 1,514.2 L (400 gal) of nitric acid have been calculated using the ARCHIE (DOT et al. 1989). All accidents were evaluated as ground-level releases.

SOURCE TERMS

The source terms were specified by the customer for seven cases as described in Appendix A. The cases are listed below.

- Case 1: Release from the 222-S Laboratory due to a fire caused by a seismic event. The calculation was requested for onsite 900 m northwest at ground-level release.

- Case 2: Release from the 222-S Laboratory due to a fire caused by a seismic event. The calculation was requested for offsite 13.5 km west at ground-level release.

- Case 3: Release from Tank 219-S due to a dropped cover block. The calculation was requested for onsite 900 meters northwest at ground-level release.

- Case 4: Release from Tank 219-S due to a dropped cover block. The calculation was requested for offsite 13.5 km west at ground-level release.

- Case 5: The accident involves an unshielded 100-ml polyethylene bottle sample containing a slurries sample from Waste Tank 241-AZ-101. The exposure to a facility worker from gamma-rays was requested by the customer. The dimensions of the bottle were specified by the customer as 4.762-cm (1.875-in.) diameter and 10.16-cm (4-in.) height.

- Case 6: The accident involves a 26.7 °C (80 °F) nitric acid spill of 378.5 L (100 gal) at an ambient temperature of 37.8 °C (100 °F). Assumed a spill area of 9.3 m^2 (100 ft^2).

- Case 7: The accident involves a 26.7 °C (80 °F) nitric acid spill of 1,514.2 L (400 gal) at an ambient temperature of 36.8 °C (100 °F).

METHODOLOGIES AND ASSUMPTIONS

Cases 1, 2, 3, and 4 deal with the releases of isotopes from the 222-S Laboratory. The objective for these problems is to calculate the doses for a ground-level release to the onsite receptor located 900 m northwest and the offsite located at 13.5 km west using computer code GENII Version 1.485 (Napier et al. 1988). All material released is assumed respirable. The GENII input files are attached in Appendix B for reference.

For case 5, the accident involves an unshielded 100-ml polyethylene bottle sample containing a slurries sample from Waste Tank 241-AZ-101. The calculation from exposure to facility worker from gamma-rays was requested by the customer. The container (bottle) is capable of preventing alpha and beta energies from being released during the accident. The worker will stay 0.61 m (2 ft) from the bottle for 2 hours. The computer code Microshield Version 3.12 (DOT et al. 1989) was used to calculated the gamma exposure (external exposure). The Microshield calculation output is attached in Appendix C for reference.

The only isotopes of interest are ^{137}Cs, ^{137m}Ba, and ^{60}Co. These gamma-ray emitters are the dominant radiation hazard in almost all radiation transport calculations. ^{60}Co is not a fission product, but it is formed through neutron activation.

Microshield geometry of a cylindrical volume source was assumed. Source nuclides used were ^{60}Co and ^{137}Cs (assumed decayed for 1 day) of 2.0 x 10^{-3} Ci and 2.9 x 10^{-1} Ci, respectively, as gamma-ray emitters. The ^{137}Cs is decayed for 1 day to generate ^{137m}Ba of 2.7431 x 10^{-1} Ci.

For case 6, the accident was specified as the spill of 378.5 L (100 gal) of nitric acid. The calculations for concentrations at onsite 900-m and offsite 13.5-km receptors were requested by the customer. The 378.5 L (100 gal) of nitric acid is evaluated based on the spill accident at 26.7 °C (80 °F). The material was assumed to be released at an ambient temperature of 37.8 °C (100 °F). The concentration of the nitric acid was assumed to be 70% by teleconference with the customer.

The source term (evaporation rate) for nitric acid was calculated using the ARCHIE computer code (DOT et al. 1989) evaporating pool model. The evaporation rate is dependant upon volatility, normal boiling point, storage temperature of the liquid, pool area, and wind velocity.

The ARCHIE software uses a Gaussian plume model to calculate dispersion. Gaussian plume models are generally not regarded as being valid at distances less than 100 m from sources, and the presence of buildings and equipment can create complicated airflow patterns in the vicinity of the accident under consideration. Nonetheless, the results of the use of the Gaussian plume model calculations should be regarded as being conservative. Actual concentrations may be considerably less than those calculated here but are very unlikely to be more. A sample ARCHIE calculation output run is attached in Appendix D for reference.

The formula used to calculate the onsite and offsite exposures downwind concentrations of nitric acid were calculated as follows:

$$\chi = \text{Source Term} \times \left(\frac{\chi}{Q}\right)_{ss} \times \text{Conv1} \times \text{Conv2}$$

where

χ	=	The concentration of chemical compound that reaches the designated receptor (mg/m^3)
Source Term	=	Release rate from the 222-S Laboratory (lb/min)
Conv1	=	The conversion from pound (lb) to milligram (mg). (453592.37 mg/1.0 lb)
Conv2	=	The conversion from minutes to seconds (1.0 min/60 s)
χ/Q_{ss}	=	Steady state χ/Q (s/m^3).

The atmospheric dispersion coefficients (χ/Q_{ss}) at ground-level release from the 222-S Laboratory were computed using the GXQ version 3.1 (Hey 1993) dosimetry program. The χ/Q_{ss} for a range of atmospheric stability classes and wind speeds are shown in Tables 6 and 7 at distances of 900 m and 13.5 km, respectively.

The conversion from mg/m^3 to ppm (part per million) by volume is performed using the following equation, which is valid at 25 °C:

$$\text{ppm} = \frac{\frac{mg}{m^3} \times 24.45}{M.W.}$$

M.W. = Molecular Weight

Case 7 involves a spill of 1,514.2 L (400 gal) of nitric acid. The nitric acid temperature is at 26.7 °C (80 °F). The ambient temperature is 37.8 °C (100 °F). The concentration of the nitric acid was assumed to be 70% by teleconference with the customer.

The spill area for case 7 was calculated by assuming a spill area of 0.15 m^2/L for gravel spill surface condition (Clewell 1983). The 1,514-L (400-gal) spill area is 227.117 m^2 (2,444.751 ft^2).

RECEPTOR DESCRIPTIONS

- Onsite: For the ground level releases, the receptor is normally 100 m in the worst direction (WHC-CM-4-46). Doses calculated for the onsite receptor include inhalation and submersion. For the purpose of this analysis, the maximum individual for acute ground-level releases from the 222-S Laboratory was specified by the customer to be located at 900 m northwest with an acute 95 percentile X/Q of 7.2×10^{-4} s/m^3.

- Site Boundary: Receptor at the site boundary in the worst direction. Where the site is bounded by the Columbia River, the site boundary is taken to be at the nearer bank of the river. This receptor is assumed to stay at this location for the duration of the accident. Doses calculated include inhalation and submersion.

- Offsite: Residence of the ingestion pathway receptor. This receptor receives acute inhalation and submersion doses, but in addition is assumed to grow his own food, including a variety of crops, meat, and dairy products and continues to do so at his location for 50 years following the accident and also be exposed to direct radiation due to ground contamination while working in his fields. No credit is taken for uncontaminated foodstuffs brought in from outside the area. For the purpose of this analysis, the maximum individual for acute ground-level releases from the 222-S Laboratory was specified by the customer to be located at 13.5 km west, with an acute 95 percentile X/Q of 1.6×10^{-5} s/m^3.

CODE DOCUMENTATION

- GENII version 1.485 (12/3/90)
- GENII Default Parameter Values (28-Mar-90 RAP)
- Radionuclide Master Library (11/15/90 PDR)
- Food Transfer Factor Library (RAP 29-Aug-88)
- External Dose Factor Library (8-May-90-RAP)
- Internal Dose Increments, Maximum Worst Case Solubilities, (12/3/90)
- Joint Frequency Data: 200 Area, 10 m, Pasquill A-F (1983-1987 Average)
- Microshield version 3.12 (1982)
- Automated Resource for Chemical Hazard Incident Evaluation (ARCHIE), 1989
- GXQ Version 3.1 (1993)

RESULTS

The resulting effective dose equivalents (EDE) and limiting organ doses for onsite and site boundary receptors calculated by GENII with 95 percentile meteorology are shown in Tables 1, 2, 3, and 4 for cases 1, 2, 3, and 4, respectively. Inhalation and submersion doses were 50-year committed doses based on an acute uptake. Submersion doses were calculated using a semi-infinite cloud model.

Any external dose due to plume submersion was included in both the EDE and organ dose for GENII calculations. Building wake and plume meander were not taken into account because no release durations were specified by the customer for cases 1, 2, 3, and 4.

Table 1. Doses Calculated for Onsite 900-m Northwest Releases from the 222-S Laboratory Due to a Fire Caused by a Seismic Event (Case 1).

Receptor	Dose type	EDE (rem)	Limiting organ (rem)
Onsite (900 m, NW)	Inhalation	6.2 E-01	1.1 E+01 (BONE SUR)
	Submersion	1.4 E-05	1.4 E-05
	Total	6.2 E-01	1.1 E+01 (BONE SUR)

EDE = effective dose equivalent.

Table 2. Dose Calculated for Offsite 13.5-km West Release from the 222-S Laboratory Due to a Fire Caused by a Seismic Event (Case 2).

Receptor	Dose type	EDE (rem)	Limiting organ (rem)
Offsite (13500 m, W)	Inhalation	1.4 E-02	2.5 E-01 (BONE SUR)
	Submersion	3.1 E-07	3.1 E-07
	Total	1.4 E-02	2.5 E-01 (BONE SUR)
IPR (Autumn, 13.5 km, W)	Inhalation	1.4 E-02	2.5 E-01 (BONE SUR) 6.0 E-03 (THYROYD)
	Submersion	3.1 E-07	3.1 E-07
	Ingestion	8.5 E-01	2.4 E-01 (BONE SUR) 2.7 E+01 (THYROYD)
	Ground shine	1.9 E-05	1.9 E-05
	Total	8.7 E-01	2.7 E+01 (THYROYD)

EDE = effective dose equivalent.
IPR = ingestion pathway receptor.

Table 3. Doses Calculated for Onsite 900-m Northwest Releases from Tank 219-S Due to a Dropped Cover Block (Case 3).

Receptor	Dose type	EDE (rem)	Limiting organ (rem)
Onsite (900 m, NW)	Inhalation	5.1 E-04	9.0 E-03 (BONE SUR)
	Submersion	7.9 E-08	7.9 E-08
	Total	5.1 E-04	9.0 E-03 (BONE SUR)

EDE = effective dose equivalent.

Table 4. Dose Calculated for Offsite 13.5-km West Release from Tank 219-S Due to a Dropped Cover Block (Case 4).

Receptor	Dose Type	EDE (rem)	Limiting Organ (rem)
Offsite (13500 m, W)	Inhalation	1.1 E-05	2.0 E-04 (BONE SUR)
	Submersion	1.7 E-09	1.7 E-09
	Total	1.1 E-05	2.0 E-04 (BONE SUR)
IPR (Autumn, 13.5 km, W)	Inhalation	1.1 E-05	2.0 E-04 (BONE SUR)
	Submersion	1.7 E-09	1.7 E-09
	Ingestion	1.4 E-04	5.1 E-04 (BONE SUR)
	Ground shine	2.9 E-06	2.9 E-06
	Total	1.5 E-04	5.1 E-04 (BONE SUR)

EDE = effective dose equivalent.
IPR = ingestion pathway receptor.

The exposure to a facility worker from an unshielded 100-ml polyethylene bottle using computer code Microshield 3.12 is reported in Table 5. The accident duration was assumed to be 2 hours. It was assumed the ^{137}Cs is decayed for 1 day to produce the daughter product ^{137m}Ba of 2.7431 x 10^{-1} Ci.

Table 5. Exposure To Facility Worker Due To A Dropped Sample (Case 5).

Exposure rate based on Microshield calculations
2.4 E+02 mr/h
Total dose received for assumed worker standing 2.0 ft from unshielded bottle for 2 hours
4.8 E+02 mr

Tables 6 and 7 were calculated using the GXQ version 3.1 (Hey 1993) dosimetry program. The onsite and offsite atmospheric dispersion coefficients (χ/Q_{ss}) are dependent upon the wind speed, distance, and atmospheric stability class.

Table 6. Onsite 900-Meter Atmospheric Dispersion Coefficients vs Wind Speeds.

Atm. stab. class	Wind speeds (m/s)										
	0.89	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
	Atmospheric dispersion coefficients (χ/Q_w) at onsite 900 m										
A	5.7 E-06	3.4 E-06	2.6 E-06	2.0 E-06	1.7 E-06	1.5 E-06	1.3 E-06	1.1 E-06	1.0 E-06	9.3 E-07	8.5 E-07
B	2.9 E-05	1.7 E-05	1.3 E-05	1.0 E-05	8.5 E-06	7.2 E-06	6.4 E-06	5.6 E-06	5.1 E-06	4.6 E-06	4.2 E-06
C	6.6 E-05	3.9 E-05	3.0 E-05	2.4 E-05	2.0 E-05	1.7 E-05	1.5 E-05	1.3 E-05	1.2 E-05	1.1 E-05	9.8 E-06
D	1.8 E-04	1.1 E-04	8.0 E-05	6.4 E-05	5.3 E-05	4.6 E-05	4.0 E-05	3.6 E-05	3.2 E-05	2.9 E-05	2.7 E-05
E	3.7 E-04	2.2 E-04	1.6 E-04	1.3 E-04	1.1 E-04	9.4 E-05	8.2 E-05	7.3 E-05	6.6 E-05	6.0 E-05	5.5 E-05
F	8.3 E-04	4.9 E-04	3.7 E-04	3.0 E-04	2.5 E-04	2.1 E-04	1.8 E-04	1.6 E-04	1.5 E-04	1.3 E-04	1.2 E-04
G	2.1 E-03	1.2 E-03	9.1 E-04	7.3 E-04	6.1 E-04	5.2 E-04	4.6 E-04	4.1 E-04	3.7 E-04	3.3 E-04	3.1 E-04

Table 7. Offsite 13.5-km Atmospheric Dispersion Coefficients vs Wind Speeds.

Atm. stab. class	Wind speeds (m/s)										
	0.89	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
	Atmospheric dispersion coefficients (χ/Q_w) at offsite 13.5 km										
A	2.3 E-07	1.4 E-07	1.0 E-07	8.1 E-08	6.8 E-08	5.8 E-08	5.1 E-08	4.5 E-08	4.1 E-08	3.7 E-08	3.4 E-08
B	3.0 E-07	1.8 E-07	1.4 E-07	1.1 E-07	9.0 E-08	7.7 E-08	6.8 E-08	6.0 E-08	5.4 E-08	4.9 E-08	4.5 E-08
C	5.0 E-07	2.9 E-07	2.2 E-07	1.8 E-07	1.5 E-07	1.3 E-07	1.1 E-07	9.8 E-08	8.8 E-08	8.0 E-08	7.4 E-08
D	2.9 E-06	1.7 E-06	1.3 E-06	1.0 E-06	8.5 E-07	7.3 E-07	6.4 E-07	5.7 E-07	5.1 E-07	4.7 E-07	4.3 E-07
E	7.2 E-06	4.3 E-06	3.2 E-06	2.6 E-06	2.1 E-06	1.8 E-06	1.6 E-06	1.4 E-06	1.3 E-06	1.2 E-06	1.1 E-06
F	1.8E-05	1.1 E-05	8.0 E-06	6.4 E-06	5.3 E-06	4.6 E-06	4.0 E-06	3.6 E-06	3.2 E-06	2.9 E-06	2.7 E-06
G	4.5 E-05	2.7 E-05	2.0 E-05	1.6 E-05	1.3 E-05	1.1 E-05	1.0 E-05	8.9 E-06	8.0 E-05	7.3 E-06	6.7 E-06

The vapor evolution rates calculated by ARCHIE at different wind speeds for cases 6 and 7 are shown in Table 8. The vapor evolution rate is not dependant on the atmospheric stability class. The vapor evaporation rate is dependant upon volatility, normal boiling point, storage temperature of the liquid, pool area, and wind velocity.

Table 8. Vapor Evolution Rates vs Wind Speeds.

Case	Wind Speeds (m/s)										
	0.89	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
	Vapor evolution rates (lb/min)										
6	0.094	0.138	0.171	0.202	0.232	0.26	0.287	0.314	0.34	0.365	0.389
7	2.28	3.38	4.17	4.93	5.68	6.35	7.02	7.66	8.29	8.91	9.51

A sensitivity analysis was performed for cases 6 and 7 to determine which condition of the wind speeds and atmospheric stability class resulted in the highest concentration. As shown in Tables 9 and 10, the atmospheric stability class G at wind speeds ranging from 0.89 to 6.0 m/s produces the most conservative results. Tables 9 and 10 for the onsite and offsite receptors show that the concentrations are functions of wind speed and atmospheric dispersion coefficients (χ/Q_{ss}).

Tables 9 and 10 show that onsite and offsite concentrations for wind speeds ranging from 0.89 to 6.0 m/s verses atmospheric stability class G are under the criteria limit.

The nitric acid criteria limits according to WHC-CM-4-46 are as follows:

15 ppm (38.65 mg/m^3) $\geq$ Onsite

2 ppm (5.15 mg/m^3) $\geq$ Offsite.

Table 9. Onsite 900-Meter Concentrations vs Wind Speeds.

Atm. stab. class	Wind speeds (m/s)										
	0.89	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
Onsite 900-m concentrations for case 6 (mg/m³)											
A	4.1 E-03	3.5 E-03	3.4 E-03	3.1 E-03	3.0 E-03	2.9 E-03	2.8 E-03	2.6 E-03	2.6 E-03	2.6 E-03	2.5 E-03
B	2.1 E-02	1.8 E-02	1.7 E-02	1.5 E-02	1.5 E-02	1.4 E-02	1.4 E-02	1.3 E-02	1.3 E-02	1.3 E-02	1.2 E-02
C	4.7 E-02	4.1 E-02	3.9 E-02	3.7 E-02	3.5 E-02	3.3 E-02	3.3 E-02	2.8 E-02	3.1 E-02	3.0 E-02	2.9 E-02
D	1.3 E-01	1.1 E-01	1.0 E-01	9.8 E-02	9.3 E-02	9.0 E-02	8.7 E-02	7.6 E-02	8.2 E-02	8.0 E-02	7.9 E-02
E	2.6 E-01	2.3 E-01	2.1 E-01	2.0 E-01	1.9 E-01	1.8 E-01	1.8 E-01	1.7 E-01	1.7 E-01	1.7 E-01	1.6 E-01
F	6.0 E-01	5.1 E-01	4.8 E-01	4.6 E-01	4.4 E-01	4.1 E-01	3.9 E-01	3.8 E-01	3.9 E-01	3.6 E-01	3.5 E-01
G	1.5 E+00	1.3 E+00	1.2 E+00	1.1 E+00	1.1 E+00	1.0 E+00	1.0 E+00	9.7 E-01	9.5 E-01	9.1 E-01	9.1 E-01
Onsite 900-m concentrations for case 7 (mg/m³)											
A	9.8 E-02	8.6 E-02	8.2 E-02	7.5 E-02	7.3 E-02	7.2 E-02	6.9 E-02	6.4 E-02	6.3 E-02	6.3 E-02	6.1 E-02
B	5.0 E-01	4.3 E-01	4.1 E-01	3.7 E-01	3.6 E-01	3.5 E-01	3.4 E-01	3.2 E-01	3.2 E-01	3.1 E-01	3.0 E-01
C	1.1 E+00	9.9 E-01	9.5 E-01	8.9 E-01	8.6 E-01	8.2 E-01	8.0 E-01	6.9 E-01	7.5 E-01	7.4 E-01	7.0 E-01
D	3.1 E+00	2.8 E+00	2.5 E+00	2.4 E+00	2.3 E+00	2.2 E+00	2.1 E+00	1.9 E+00	2.0 E+00	2.0 E+00	1.9 E+00
E	6.4 E+00	5.6 E+00	5.0 E+00	4.8 E+00	4.7 E+00	4.5 E+00	4.4 E+00	4.2 E+00	4.1 E+00	4.0 E+00	4.0 E+00
F	1.5 E+01	1.2 E+01	1.2 E+01	1.1 E+01	1.1 E+01	1.0 E+01	9.6 E+00	9.3 E+00	9.4 E+00	8.8 E+00	8.6 E+00
G	3.7 E+01	3.0 E+01	2.9 E+01	2.7 E+01	2.6 E+01	2.5 E+01	2.4 E+01	2.4 E+01	2.3 E+01	2.2 E+01	2.2 E+01

Table 10. Offsite 13.5-km Concentrations vs Wind Speeds.

Atm. stab. class	Wind speeds (m/s)										
	0.89	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.6
Offsite 13.5-km concentrations for case 6 (mg/m^3)											
A	2.3 E-03	1.5 E-04	1.3 E-04	1.2 E-04	1.2 E-04	1.1 E-04	1.1 E-04	1.1 E-04	1.1 E-04	1.0 E-04	1.0 E-04
B	2.1 E-04	1.9 E-04	1.8 E-04	1.7 E-04	1.6 E-04	1.5 E-04	1.5 E-04	1.4 E-04	1.4 E-04	1.4 E-04	1.3 E-04
C	3.6 E-04	3.0 E-04	2.8 E-04	2.7 E-04	2.6 E-04	2.6 E-04	2.4 E-04	2.3 E-04	2.3 E-04	2.2 E-04	2.2 E-04
D	2.1 E-03	1.8 E-03	1.7 E-03	1.5 E-03	1.5 E-03	1.4 E-03	1.4 E-03	1.4 E-03	1.3 E-03	1.3 E-03	1.3 E-03
E	5.1 E-03	4.5 E-03	4.1 E-03	4.0 E-03	3.7 E-03	3.5 E-03	3.5 E-03	3.3 E-03	3.3 E-03	3.3 E-03	3.2 E-03
F	1.3 E-02	1.1 E-02	1.0 E-02	9.8 E-03	9.3 E-03	9.0 E-03	8.7 E-03	8.5 E-03	8.2 E-03	8.0 E-03	7.9 E-03
G	3.2 E-02	2.8 E-02	2.6 E-02	2.4 E-02	2.3 E-02	2.2 E-02	2.2 E-02	2.1 E-02	2.1 E-01	2.0 E-02	2.0 E-02
Offsite 13.5-km concentrations for case 7 (mg/m^3)											
A	4.0 E-03	3.6 E-03	3.2 E-03	3.0 E-03	2.9 E-03	2.8 E-03	2.7 E-03	2.6 E-03	2.6 E-03	2.5 E-03	2.4 E-03
B	5.2 E-03	4.6 E-03	4.4 E-03	4.1 E-03	3.9 E-03	3.7 E-03	3.6 E-03	3.5 E-03	3.4 E-03	3.3 E-03	3.2 E-03
C	8.7 E-03	7.4 E-03	6.9 E-03	6.7 E-03	6.4 E-03	6.2 E-03	5.8 E-03	5.7 E-03	5.5 E-03	5.4 E-03	5.3 E-03
D	5.1 E-02	4.3 E-02	4.1 E-02	3.7 E-02	3.6 E-02	3.5 E-02	3.4 E-02	3.3 E-02	3.2 E-02	3.2 E-02	3.1 E-02
E	1.3 E-01	1.1 E-01	1.0 E-01	9.7 E-02	9.0 E-02	8.6 E-02	8.5 E-02	8.1 E-02	8.1 E-02	8.1 E-02	7.9 E-02
F	3.1 E-01	2.8 E-01	2.5 E-01	2.4 E-01	2.3 E-01	2.2 E-01	2.1 E-01	2.1 E-01	2.0 E-01	2.0 E-01	1.9 E-01
G	7.8 E-01	6.9 E-01	6.3 E-01	6.0 E-01	5.6 E-01	5.3 E-01	5.3 E-01	5.2 E-01	5.0 E+00	4.9 E-01	4.8 E-01

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APPENDIX A

INTERNAL MEMO FROM E. E. LEITZ TO J. C. VAN KEUREN

DATE: October 18, 1993

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Westinghouse Hanford Company — **Internal Memo**

From: Restoration & Remediation Safety Analysis — EEL-29540-93-039
Phone: 376-8079 H4-68
Date: August 30, 1993
Subject: DOSE CONSEQUENCE ANALYSES FOR THE 222-S LABORATORY

To: J. C. Van Keuren H4-64

AUG 30 1993

cc: F. R. Bourger H4-68
L. E. Johnson H4-70
J. C. Lavender H4-70
EEL File/LB

Attached are 6 cases requiring dose consequence analyses. These analyses are required to support the 222-S Laboratory Phase II, Interim Safety Basis. We will need preliminary results by September 3, 1993 to support peer review of the accident analysis and initiate Safety Classification of systems and structures activities. The final reviewed analyses will be required by September 13, 1993 to support the functional review.

Please call Fred Bourger (376-8564) or myself, should you require additional information.

Emil E. Leitz

E. E. Leitz
Manager

siw

Attachment

Case 1. Release from the 222-S Laboratory due to a fire caused by a seismic event. Please calculate doses (ground level release) to the onsite individual at 100 m and 900 m NW (242-S).

Case 2. Release from the 222-S Laboratory due to a fire caused by a seismic event. Please calculate doses (ground level release) to the offsite individual at 13.5 km W.

Case 3. Release from Tank 219-S due to a dropped cover block. Please calculate doses (ground level release) to the onsite individual at 100 m and 900 m NW (242-S). Assume a 10% release fraction and all material released is respirable.

Case 4. Release from Tank 219-S due to a dropped cover block. Please calculate doses (ground level release) to the offsite individual at 13.5 km W. Assume a 10% release fraction and all material released is respirable.

Mo–' Concentration?

Case 5. Exposure to facility worker due to a dropped sample. Please calculate exposure to facility worker due to a spill of a 100 ml sample, specific gravity 1.7, spill depth 0.13 cm and 0.077 m^2.

Case 6. Exposure to facility worker due to a nitric acid spill. Please calculate exposure to onsite individual at 100 m and 900 m NW (242-S) for a 100 gallon nitric acid spill, 100 sq ft, depth of 0.38 cm, at 70° (Class F 1 m/s) and 80° (Class D 2 m/s).

$$\frac{(100\ \text{gal})\left(\frac{\text{ft}^3}{7.5\ \text{gal}}\right)}{(.38\ \text{cm})\left(\frac{\text{ft}}{30.5\ \text{cm}}\right)} = 1070\ \text{ft}^2$$

SOURCE TERM FOR CASE #1 and #2:

Isotope	Total Ci	Release Fraction	Source Term
H-3	1.02E+00	1.0	1.02E+00
C-14	3.21E-02	1E-02	3.21E-04
Co-60	2.16E+00	1E-02	2.16E-02
Sr-90	1.25E+02	1E-03	1.25E-01
Tc-99	2.64E-01	1E-03	2.64E-04
I-129	2.33E-01	5E-01	1.73E-01
Cs-137	3.16E+02	1E-02	3.16E+00
Pm-147	3.80E+01	1E-03	3.80E-02
Pu-238	1.09E-01	1E-03	1.09E-04
Pu-239	1.10E+01	1E-03	1.10E-02
Am-241	6.01E-01	1E-03	6.01E-04
U-234	9.76E-02	1E-03	9.76E-05
U-235	2.86E-03	1E-03	2.86E-06
U-238	6.64E-03	1E-03	6.64E-06
	4.95E+02		

SOURCE TERM FOR CASE #3 and #4:

Isotope	Ave Ci/L	Total Ci
H-3	1.63E-07	1.04E-01
C-14	5.14E-09	3.28E-03
Co-60	3.46E-07	2.21E-01
Sr-90	2.00E-05	1.27E+01
Tc-99	4.23E-08	2.70E-02
I-129	3.73E-08	2.38E-02
Cs-137	5.06E-05	3.23E+01
Pm-147	6.08E-06	3.88E+00
Pu-238	1.74E-08	1.11E-02
Pu-239	1.48E-07	9.44E-02
Am-241	9.62E-08	6.14E-02
U-234	1.56E-08	9.96E-03
U-235	4.58E-10	2.92E-04
U-238	1.06E-09	6.78E-04
	7.75E-05	4.95E+01

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SOURCE TERM FOR CASE #5:

Isotope	uCi/gm	uCi	
H-3	1.5E-02	2.6E+00	uCi/100ml
C-14	1.9E-03	3.2E-01	
Co-60	1.2E+01	2.0E+03	
Se-79	4.5E-03	7.7E-01	
Sr-90	2.4E+04	4.1E+06	
Tc-99	8.1E-01	1.4E+02	
Ru-106	1.4E+03	2.4E+05	
Sb-125	1.6E+02	2.7E+04	
I-129	6.5E-04	1.1E-01	
Cs-134	2.7E+01	4.6E+03	
Cs-137	1.7E+03	2.9E+05	
Ce-144	2.7E+03	4.9E+05	
Eu-154	8.2E+01	1.3E+04	
U	1.2E-03	1.0E-03	
Np-237	2.3E-02	3.9E+00	
Pu-238	6.9E-01	1.2E+02	
Pu-239/240	4.7E+00	2.2E+02	
Pu-241	3.7E+01	6.3E+03	
Am-241	5.9E+01	1.0E+04	
Cm-242	1.3E-01 uCi/L	1.3E-02	
Cm-244	6.7E-01 uCi/L	6.7E-02	

DON'T SAY IT --- *Write It!*

DATE: 9-15-93

TO: J. C. Van Keuren H4-64

FROM: F. H. Bourger H4-68

Telephone: 6-8564

cc: L. E. Johnson H4-70
E. E. Leitz H4-68
J. C. Lavender H4-70
L. V. Nguyen H4-64

SUBJECT: REVISION TO REQUEST FOR DOSE CONSEQUENCE ANALYSIS FOR THE 222-S LABORATORY (Internal Memo EEL-29540-93-039)

The subject memo (EEL-29540-93-039) Dose Consequence analysis for the 222-S Laboratory dated August 30, 1993, requested by E. E. Leitz is revised to replace source terms for case 1,2,3 and 4, as described in an attachment to that memo, cases 5 and 6 remain unchanged. The new revised source terms for each of the cases mentioned above are attached. Preliminary results will be needed by September 16, 1993 to support peer and functional review of the accident analysis and support the safety classification chapter. The final approved analysis will be required by September 23, 1993.

Please give me a call, should you require additional information.

Attachment

Case 1. Release from the 222-S Laboratory due to fire caused by a seismic event. Please calculate doses (ground level release) to the onsite individual at 100 m and 900 m NW (242-S).

Case 2. Release from the 222-S Laboratory due to fire caused by a seismic event. Please calculate doses (ground level release) to the offsite individual at 13.5 km W.

SOURCE TERM FOR CASE #1 and #2:

ISOTOPE	TOTAL Ci	RELEASE FRAC.	SOURCE TERM
H-3	1.02E+00	1.0	1.02E+00
C-14	3.21E-02	1.0	3.21E-02
Co-60	2.16E+00	5.0E-04	1.08E-03
Sr-90	1.25E+02	5.0E-04	6.25E-02
Tc-99	2.64E-01	5.0E-04	1.32E-04
I-129	2.33E-01	1.0	2.33E-01
Cs-137	3.16E+02	5.0E-04	1.58E-01
Pm-147	3.80E+01	5.0E-04	1.90E-02
Pu-238	1.09E-01	5.0E-04	5.45E-05
Pu-239	1.10E+01	5.0E-04	5.50E-03
Am-241	6.01E-01	5.0E-04	3.01E-04
U-234	9.76E-02	5.0E-04	4.88E-05
U-235	2.86E-03	5.0E-04	1.43E-06
U-238	6.64E-03	5.0E-04	3.32E-06

Case 3. Release from Tank 219-S due to a dropped cover block. Please calculate doses (ground level release) to the onsite individual at 100m and 900 m NW (242-S).

Case 4. Release from Tank 219-S due to a dropped cover block. Please calculate doses (ground level release) to the offsite individual at 13.5 km W.

SOURCE TERM FOR CASE #3 and #4:

ISOTOPE	TOTAL Ci	RELEASE FRAC. (4.0E-05*0.7)	SOURCE TERM
H-3	1.04E-01	2.8E-05	2.91E-06
C-14	3.28E-03	2.8E-05	9.18E-08
Co-60	2.21E-01	2.8E-05	6.19E-06
Sr-90	1.27E+01	2.8E-05	3.56E-04
Tc-99	2.70E-02	2.8E-05	7.56E-07
I-129	2.38E-02	2.8E-05	6.66E-07
Cs-137	3.23E+01	2.8E-05	9.04E-04
Pm-147	3.88	2.8E-05	1.09-04
Pu-238	1.11E-02	2.8E-05	3.11E-07
Pu-239	9.44E-02	2.8E-05	2.64-06
Am-241	6.14E-02	2.8E-05	1.72-06
U-234	9.96E-03	2.8E-05	2.79E-08
U-235	2.92E-04	2.8E-05	8.18E-09
U-238	6.78E-04	2.8E-05	1.90E-08

DON'T SAY IT --- *Write It!*.

DATE: 9-21-93

TO: J. C. Van Keuren H4-64

FROM: F. H. Bourger FHB H4-68

Telephone: 6-8564

cc: L. E. Johnson H4-70
E. E. Leitz H4-68 EEL
J. C. Lavender H4-70
L. V. Nguyen H4-64

SUBJECT: ADDITION TO REQUEST FOR DOSE AND EXPOSURE CONSEQUENCE ANALYSIS FOR THE 222-S LABORATORY

Please add a case 7 to the (EEL-29540-93-039) Dose Consequence analysis for the 222-S Laboratory dated August 30, 1993, requested by E. E. Leitz. Case 7 is a 400 gallon release to an open field (asphalt) of (70% conc.) nitric acid.

Please calculate exposure to the onsite individual at 900 m NW (242-S) and the offsite receptor at 13.5 km W at 70° (class F 1 m/s) and 80° (class D 2 m/s).

Please add this analysis to the existing analysis which is in the review cycle.

Please give me a call, should you require additional information.

Fred H. Bourger

54-3000-101 (12/92) GEF014

APPENDIX B

GENII INPUT DECKS

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ONSITE 100 METERS ACUTE GROUND LEVEL RELEASE FOR CASE 1

```
######################### Program GENII Input File ###########  8 Jul 88 ####
Title: ACUTE ONSITE FOR 900 METER NW RELEASE
       \SAMPL\G-AIR.AC
OPTIONS========================= Default =====================================
F    Near-field scenario?         (Far-field)    NEAR-FIELD: narrowly-focused
F    Population dose?            (Individual)                release, single site
T    Acute release?                (Chronic)     FAR-FIELD:  wide-scale release,
     Maximum Individual data set used                        multiple sites
                                   Complete                                Complete
TRANSPORT OPTIONS============      Section     EXPOSURE PATHWAY OPTIONS=====  Section
T  Air Transport                     1         F  Finite plume, external       5
F  Surface Water Transport           2         T  Infinite plume, external     5
F  Biotic Transport (near-field)    3,4        F  Ground, external             5
F  Waste Form Degradation (near)    3,4        F  Recreation, external         5
                                               T  Inhalation uptake            5,6
REPORT OPTIONS========================         F  Drinking water ingestion     7,8
T  Report AEDE only                            F  Aquatic foods ingestion      7,8
T  Report by radionuclide                      F  Terrestrial foods ingestion  7,9
T  Report by exposure pathway                  F  Animal product ingestion     7,10
F  Debug report on screen                      F  Inadvertent soil ingestion

INVENTORY ###################################################################

 4   Inventory input activity units: (1-pCi  2-uCi  3-mCi  4-Ci  5-Bq)
 0   Surface soil source units (1- m2  2- m3  3- kg)
     Equilibrium question goes here

    --------|----Release Terms------|----------Basic Concentrations---------|
    Use when|  transport selected   | near-field scenario, optionally       |
    --------|-----------------------|---------------------------------------|
    Release |        Surface Buried |       Surface Deep    Ground  Surface|
    Radio-  |Air     Water   Waste  |Air    Soil    Soil    Water   Water  |
    nuclide |/yr     /yr     /m3    |/m3    /unit   /m3     /L      /L     |
    --------|------- ------- -------|------- ------- ------- ------- -------|
    H 3      1.02
    C 14     3.2E-02
    CO60     1.1E-03
    SR90     6.3E-02
    Y 90     6.3E-02
    TC99     1.3E-04
    I 129    2.3E-01
    CS137    1.6E-01
    PM147    1.9E-02
    PU238    5.5E-05
    PU239    5.5E-03
    AM241    3.0E-04
    U 234    4.9E-05
    U 235    1.4E-06
    U 238    3.3E-06
    --------|----Derived Concentrations-----|
```

```
      Use when|   measured values are known    |
      --------|--------------------------------|
      Release |Terres. Animal  Drink   Aquatic |
      Radio-  |Plant   Product Water   Food    |
      nuclide |/kg     /kg     /L      /kg     |
      --------|------- ------- ------- -------|

TIME ########################################################################

1     Intake ends after (yr)
50    Dose calc. ends after (yr)
0     Release ends after (yr)
0     No. of years of air deposition prior to the intake period
0     No. of years of irrigation water deposition prior to the intake period

FAR-FIELD SCENARIOS (IF POPULATION DOSE) ####################################

0          Definition option: 1-Use population grid in file POP.IN
0                             2-Use total entered on this line

NEAR-FIELD SCENARIOS ########################################################

           Prior to the beginning of the intake period: (yr)
0            When was the inventory disposed?  (Package degradation starts)
0            When was LOIC?  (Biotic transport starts)
0          Fraction of roots in upper soil (top 15 cm)
0          Fraction of roots in deep soil
0          Manual redistribution: deep soil/surface soil dilution factor
0          Source area for external dose modification factor (m2)
TRANSPORT ###################################################################
           ====AIR TRANSPORT================================SECTION 1=====
                   0-Calculate PM            |0       Release type (0-3)
3          Option: 1-Use chi/Q or PM value   |F       Stack release (T/F)
                   2-Select MI dist & dir    |0       Stack height (m)
                   3-Specify MI dist & dir   |0       Stack flow (m3/sec)
0          Chi/Q or PM value                 |0       Stack radius (m)
7.0        MI sector index (1=S)             |0       Effluent temp. (C)
900.0      MI distance from release point (m)|0       Building x-section (m2)
T          Use jf data, (T/F) else chi/Q grid|0       Building height (m)

           ====SURFACE WATER TRANSPORT======================SECTION 2=====
0          Mixing ratio model: 0-use value, 1-river, 2-lake
0          Mixing ratio, dimensionless
0          Average river flow rate for: MIXFLG=0 (m3/s), MIXFLG=1,2 (m/s),
0          Transit time to irrigation withdrawl location (hr)
           If mixing ratio model > 0:
0            Rate of effluent discharge to receiving water body (m3/s)
0            Longshore distance from release point to usage location (m)
0            Offshore distance to the water intake (m)
0            Average water depth in surface water body (m)
0            Average river width (m), MIXFLG=1 only
0            Depth of effluent discharge point to surface water (m), lake only
```

```
          ====WASTE FORM AVAILABILITY==========================SECTION 3=====
0         Waste form/package half life, (yr)
0         Waste thickness, (m)
0         Depth of soil overburden, m

          ====BIOTIC TRANSPORT OF BURIED SOURCE================SECTION 4=====
T         Consider during inventory decay/buildup period (T/F)?
T         Consider during intake period (T/F)?    | 1-Arid non agricultural
0         Pre-Intake site condition...............| 2-Humid non agricultural
                                                  | 3-Agricultural

EXPOSURE ###################################################################

          ====EXTERNAL EXPOSURE================================SECTION 5=====
          Exposure time:                      |   Residential irrigation:
0           Plume (hr)                        | T      Consider: (T/F)
0           Soil contamination (hr)           | 0      Source: 1-ground water
0           Swimming (hr)                     |                2-surface water
0           Boating (hr)                      | 0      Application rate (in/yr)
0           Shoreline activities (hr)         | 0      Duration (mo/yr)
0         Shoreline type: (1-river, 2-lake, 3-ocean, 4-tidal basin)
0         Transit time for release to reach aquatic recreation (hr)
1.0       Average fraction of time submersed in acute cloud (hr/person hr)

          ====INHALATION=======================================SECTION 6=====
8766.0    Hours of exposure to contamination per year
0         0-No resus-  1-Use Mass Loading         2-Use Anspaugh model
0           pension      Mass loading factor (g/m3)   Top soil available (cm)

          ====INGESTION POPULATION=============================SECTION 7=====
0         Atmospheric production definition (select option):
0           0-Use food-weighted chi/Q, (food-sec/m3), enter value on this
line
            1-Use population-weighted chi/Q
            2-Use uniform production
            3-Use chi/Q and production grids (PRODUCTION will be overridden)
0         Population ingesting aquatic foods, 0 defaults to total (person)
0         Population ingesting drinking water, 0 defaults to total (person)
F         Consider dose from food exported out of region (default=F)

          Note below: S* or Source: 0-none, 1-ground water, 2-surface water
                                    3-Derived concentration entered above
          ==== AQUATIC FOODS / DRINKING WATER INGESTION==========SECTION 8====

F         Salt water? (default is fresh)

          USE        TRAN-  PROD-     -CONSUMPTION- |
          ?   FOOD   SIT    UCTION    HOLDUP  RATE  |
          T/F TYPE   hr     kg/yr     da      kg/yr |      DRINKING WATER
          --- ------ -----  --------  ------  ----- |------------------------
          F   FISH   0.00   0.0E+00    0.00    0.0  | 0    Source (see above)
          F   MOLLUS 0.00   0.0E+00    0.00    0.0  | T    Treatment? T/F
```

F	CRUSTA	0.00	0.0E+00	0.00	0.0	0	Holdup/transit(da)
F	PLANTS	0.00	0.0E+00	0.00	0.0	0	Consumption (L/yr)

====TERRESTRIAL FOOD INGESTION=====================SECTION 9=====

USE ? T/F	FOOD TYPE	GROW TIME da	--IRRIGATION-- S *	RATE in/yr	TIME mo/yr	YIELD kg/m2	PROD-UCTION kg/yr	--CONSUMPTION-- HOLDUP da	RATE kg/yr
F	LEAF V	0.00	0	0.0	0.0	0.0	0.0E+00	0.0	0.0
F	ROOT V	0.00	0	0.0	0.0	0.0	0.0E+00	0.0	0.0
F	FRUIT	0.00	0	0.0	0.0	0.0	0.0E+00	0.0	0.0
F	GRAIN	0.00	0	0.0	0.0	0.0	0.0E+00	0.0	0.0

====ANIMAL PRODUCTION CONSUMPTION==================SECTION 10====

USE ? T/F	FOOD TYPE	---HUMAN---- CONSUMPTION RATE kg/yr	HOLDUP da	TOTAL PROD-UCTION kg/yr	DRINK WATER CONTAM FRACT.	-------------STORED FEED------------- DIET FRAC-TION	GROW TIME da	-IRRIGATION-- S *	RATE in/yr	TIME mo/yr	YIELD kg/m3	STOR-AGE da
F	BEEF	0.0	0.0	0.00	0.00	0.00	0.0	0	0.0	0.00	0.00	0.0
F	POULTR	0.0	0.0	0.00	0.00	0.00	0.0	0	0.0	0.00	0.00	0.0
F	MILK	0.0	0.0	0.00	0.00	0.00	0.0	0	0.0	0.00	0.00	0.0
F	EGG	0.0	0.0	0.00	0.00	0.00	0.0	0	0.0	0.00	0.00	0.0
						------------FRESH FORAGE------------						
	BEEF					0.00	0.0	0	0.0	0.00	0.00	0.0
	MILK					0.00	0.0	0	0.0	0.00	0.00	0.0

##

APPENDIX C

MICROSHIELD 3.12 OUTPUT FILE

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Microshield 3.12
=================

(Westinghouse Hanford Company - #197)

Page : 1
File : 222-S.MSH
Run date: October 8, 1993
Run time: 11:09 a.m.

File Ref: __________
Date: ___/___/___
By: __________
Checked: __________

CASE: 222S-LABORATORY

GEOMETRY 7: Cylindrical source from side - cylindrical shields

Distance to detector..........................	X	63.340	cm.
Source length.................................	L	10.160	"
Dose point height from base...................	Y	0.	"
Source cylinder radius........................	T1	2.380	"
Microshield inserted air gap..................	air	60.960	"

Source Volume: 180.8 cubic centimeters

MATERIAL DENSITIES (g/cc):

Material	Source	Air gap
Air	.001220	.001220
Aluminum		
Carbon		
Concrete		
Hydrogen		
Iron		
Lead		
Lithium		
Nickel		
Tin		
Titanium		
Tungsten		
Urania		
Uranium		
Water		
Zirconium		

CASE: 222S-LABORATORY

BUILDUP FACTOR: based on TAYLOR method.
Using the characteristics of the materials in shield 1.

INTEGRATION PARAMETERS:

Number of lateral angle segments (Ntheta)..... 5
Number of azimuthal angle segments (Npsi)..... 5
Number of radial segments (Nradius)........... 5

SOURCE NUCLIDES:

Nuclide	Curies	Nuclide	Curies	Nuclide	Curies
Ba-137m	2.7430e-01	Co-60	1.9986e-03	Cs-137	2.8996e-01
N-16	0.0000e+00				

RESULTS:

Group #	Energy (MeV)	Activity (photons/sec)	Dose point flux MeV/(sq cm)/sec	Dose rate (mr/hr)
1	1.3359	7.395e+07	1.808e+03	3.263e+00
2	1.1797	7.395e+07	1.598e+03	2.968e+00
3	.6953	1.206e+04	1.542e-01	3.175e-04
4	.6641	9.132e+09	1.116e+05	2.313e+02
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
	TOTALS:	9.280e+09	1.150e+05	2.376e+02

APPENDIX D

ARCHIE OUTPUT FILE

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```
HAZARDOUS MATERIAL   = nitric acid
ADDRESS \ LOCATION   = 222-S LABORATORY
DATE OF ASSESSMENT   = 9/3/93
NAME OF  DISK FILE   = LOC-1.ASF

*** SCENARIO DESCRIPTION

    nitric acid spill at 80 degrees and 100 degrees ambient

******* LIQUID POOL EVAPORATION RATE/DURATION ESTIMATES

        Vapor evolution rate        =  2.28          lbs/min
        Evolution duration          =  44            minutes

******* TOXIC VAPOR DISPERSION ANALYSIS RESULTS

        Downwind distance to concentration of 15 ppm
        -- at groundlevel           =  107          feet

  Note: Minimum computable answer is 33 feet!
        Actual hazard distance may be less.

        See attached table(s) for further details.
```

TOXIC VAPOR DISPERSION ANALYSIS RESULTS

Downwind Distance (feet)	Downwind Distance (miles)	Groundlevel Concentration (ppm)	Source Height Concentration (ppm)	Initial Evacuation Zone Width* (feet)
100	.02	17	17	79
101	.02	16.9	16.9	78
101	.02	16.7	16.7	75
102	.02	16.6	16.6	72
102	.02	16.4	16.4	69
103	.02	16.3	16.3	66
103	.02	16.1	16.1	63
104	.02	16	16	59
104	.02	15.9	15.9	55
105	.02	15.7	15.7	51
105	.02	15.6	15.6	46
106	.02	15.4	15.4	41
106	.03	15.3	15.3	35
107	.03	15.2	15.2	26
107	.03	15	15	1

*Usually safe for < 1 hour release. Longer releases or sudden wind shifts may require a larger width or different direction for the evacuation zone. See Chapters 3 and 12 of the guide for details. Source height specified by the user for this scenario was 0 feet.

TOXIC VAPOR DISPERSION ANALYSIS RESULTS

Downwind Distance (feet)	Downwind Distance (miles)	Contaminant Arrival Time at Downwind Location (minutes)	Contaminant Departure Time at Downwind Location (minutes)
100	.02	.6	45.2
101	.02	.6	45.2
101	.02	.6	45.2
102	.02	.6	45.2
102	.02	.6	45.2
103	.02	.6	45.2
103	.02	.6	45.2
104	.02	.6	45.2
104	.02	.6	45.2
105	.02	.6	45.2
105	.02	.6	45.2
106	.02	.7	45.3
106	.03	.7	45.3
107	.03	.7	45.3
107	.03	.7	45.3

CAUTION: See guide for assumptions used in estimating these times.

INPUT PARAMETER SUMMARY

PHYSIOCHEMICAL PROPERTIES OF MATERIAL			
NORMAL BOILING POINT	=	181	degrees F
MOLECULAR WEIGHT	=	63	
LIQUID SPECIFIC GRAVITY	=	1.3832	
VAPOR PRES AT CONTAINER TEMP	=	.062	psia
	=	3.21	mm Hg
VAPOR PRES AT AMBIENT TEMP	=	.151	psia
	=	7.81	mm Hg
TOXIC VAPOR LIMIT	=	15	ppm
CONTAINER CHARACTERISTICS			
TEMP OF CONTAINER CONTENTS	=	80	degrees F
ENVIRONMENTAL/LOCATION CHARACTERISTICS			
AMBIENT TEMPERATURE	=	100	degrees F
WIND VELOCITY	=	2	mph .89 -15
ATMOSPHERIC STABILITY CLASS	=	B	
VAPOR/GAS DISCHARGE HEIGHT	=	0	feet
KEY RESULTS PROVIDED BY USER INSTEAD OF ~~BY~~ EVALUATION METHODS			
AMOUNT DISCHARGED	=	100	lbs
EVAPORATING POOL AREA	=	2444.751	ft2
KEY RESULTS OVERRIDDEN BY USER AT SOME POINT AFTER COMPUTATION			
NONE OBSERVED			

PEER REVIEW CHECKLIST

Document Reviewed: 29250-LVN-93021
Author: Loc V. Nguyen
Date: October 18, 1993
Scope of Review: Entire Document

Yes	No	NA	
[ ]	[ ]	[x]	Previous reviews complete and cover analysis, up to scope of this review, with no gaps.
[x]	[ ]	[ ]	Problem completely defined.
[ ]	[ ]	[x]	Accident scenarios developed in a clear and logical manner.
[x]	[ ]	[ ]	Necessary assumptions explicitly stated and supported.
[x]	[ ]	[ ]	Computer codes and data files documented.
[x]	[ ]	[ ]	Data used in calculations explicitly stated in document.
[x]	[ ]	[ ]	Data checked for consistency with original source information as applicable.
[x]	[ ]	[ ]	Mathematical derivations checked including dimensional consistency of results.
[x]	[ ]	[ ]	Models appropriate and used within range of validity or use outside range of established validity justified.
[x]	[ ]	[ ]	Hand calculations checked for errors. Spreadsheet results should be treated exactly the same as hand calculations.
[x]	[ ]	[ ]	Software input correct and consistent with document reviewed.
[x]	[ ]	[ ]	Software output consistent with input and with results reported in document reviewed.
[ ]	[ ]	[x]	Limits/criteria/guidelines applied to analysis results are appropriate and referenced. Limits/criteria/guidelines checked against references.
[ ]	[ ]	[x]	Safety margins consistent with good engineering practices.
[ ]	[ ]	[x]	Conclusions consistent with analytical results and applicable limits.
[x]	[ ]	[ ]	Results and conclusions address all points required in the problem statement.
[ ]	[ ]	[x]	Format consistent with appropriate NRC Regulatory Guide or other standards
[x]	[ ]	[ ]	Review calculations, comments, and/or notes are attached.

[x] [ ] [ ] **Document approved.**

Brit E. Hey ~~Brit E. Hey~~ 10/18/93

Reviewer (Printed Name and Signature) Date

[x] [ ] [ ] Analysis entered into analysis database

Loc NGUYEN Locnguyen 10/18/93

(Printed Name and Signature) Date

Peer Review Notes

1 Cases 1 through 4 have evaluations that are acceptable. It is noted however, that the concentrations are modeled as a ground level release which is conservative for the fire described in Cases 1 and 2.

2 Case 5 involves a direct gamma-ray exposure from a bottle of radioactive material containing Cs-137. Calculated dose rates are conservatively high due to lack of any accounting for bottle or source material shielding. It is noted that the calculated dose rate of 0.2 R/hr is quite high.

3 Cases 6 and 7 involve a toxic release of 70% nitric acid solution. The parametric study to determine the highest concentration resulting from the countering effects of evaporation rate and dispersion which are both functions of wind speed are commendable. Semi-independent calculations using the ARCHIE code were performed for class F stability at 0.89 m/s wind speed and 900 m. Specific gravity and vapor pressure of 70% HNO_3 at 100 °F were 1.4216 and 8.48 mm Hg respectively. These values are slightly different from the authors'. Also, ARCHIE was used to model the atmospheric dispersion instead of GXQ. The above yielded concentrations somewhat higher than the authors' but well within model uncertainties and conservatisms. ARCHIE output is attached.

It is noted that the calculated nitric acid concentration for stability class G, 0.89 m/s wind speed and onsite distance of 900 m is close to the onsite low hazard criteria (ERPG-2) of 15 ppm.

```
HAZARDOUS MATERIAL     = Nitric Acid
ADDRESS \ LOCATION     = Hanford
    LATITUDE           = 117
    LONGITUDE          = 46
DATE OF ASSESSMENT     = 1/1/93
NAME OF  DISK FILE     = LOC1.ASF

*** SCENARIO DESCRIPTION

    Case 6: Spill of 100 gallons Nitric Acid
    Spill area of 100 ft2
    Acid temperature 80 F

******* LIQUID POOL SIZE ESTIMATES


  Note: Evaporating pool area was changed  by user prior to
        use  of  pool evaporation rate  and duration model.
        User provided pool area was 100 ft2.

  Note: See last page  of printout for list of results ori-
        ginally computed by ARCHIE.

******* LIQUID POOL EVAPORATION RATE/DURATION ESTIMATES

        Vapor evolution rate       =  .102          lbs/min
        Evolution duration         =  41616         minutes

******* TOXIC VAPOR DISPERSION ANALYSIS RESULTS

        Downwind distance to concentration of .1 ppm
        -- at groundlevel          =  5736          feet

  Note: Minimum computable answer is 33 feet!
        Actual hazard distance may be less.

        See attached table(s) for further details.
```

Case 6

TOXIC VAPOR DISPERSION ANALYSIS RESULTS

Downwind Distance (feet)	Downwind Distance (miles)	Groundlevel Concentration (ppm)	Source Height Concentration (ppm)	Initial Evacuation Zone Width* (feet)
100	.02	122	122	79
503	.1	5.7	5.7	380
906	.18	2	2	670
1308	.25	1.1	1.1	960
1711	.33	.68	.68	1260
2113	.41	.48	.48	1550
2516	.48	.37	.37	1840
2918	.56	.29	.29	2140
3321	.63	.24	.24	2430
3724	.71	.2	.2	2720
4126	.79	.17	.17	3010
4529	.86	.15	.15	3310
4931	.94	.13	.13	3600
5334	1.02	.12	.12	3890
5736	1.09	.1	.1	1

.75

Loc got .51

*Usually safe for < 1 hour release. Longer releases or sudden wind shifts may require a larger width or different direction for the evacuation zone. See Chapters 3 and 12 of the guide for details. Source height specified by the user for this scenario was 0 feet.

TOXIC VAPOR DISPERSION ANALYSIS RESULTS

Downwind Distance (feet)	Downwind Distance (miles)	Contaminant Arrival Time at Downwind Location (minutes)	Contaminant Departure Time at Downwind Location (minutes)
100	.02	.6	41617.2
503	.1	2.9	41621.8
906	.18	5.2	41626.3
1308	.25	7.5	41630.9
1711	.33	9.8	41635.5
2113	.41	12.1	41640.1
2516	.48	14.3	41644.6
2918	.56	16.6	41649.2
3321	.63	18.9	41653.8
3724	.71	21.2	41658.4
4126	.79	23.5	41662.9
4529	.86	25.8	41667.5
4931	.94	28.1	41672.1
5334	1.02	30.4	41676.7
5736	1.09	32.6	41681.2

CAUTION: See guide for assumptions used in estimating these times.

INPUT PARAMETER SUMMARY

PHYSIOCHEMICAL PROPERTIES OF MATERIAL

NORMAL BOILING POINT	=	183	degrees F
MOLECULAR WEIGHT	=	63	
LIQUID SPECIFIC GRAVITY	=	1.4216	
VAPOR PRES AT AMBIENT TEMP	=	.164	psia
	=	8.48	mm Hg
TOXIC VAPOR LIMIT	=	.1	ppm

CONTAINER CHARACTERISTICS

CONTAINER TYPE	=	Vertical cylinder	
TANK DIAMETER	=	10	feet
TOTAL WEIGHT OF CONTENTS	=	1000	lbs
LIQUID HEIGHT IN CONTAINER	=	10	feet
TEMP OF CONTAINER CONTENTS	=	80	degrees F

ENVIRONMENTAL/LOCATION CHARACTERISTICS

AMBIENT TEMPERATURE	=	100	degrees F
WIND VELOCITY	=	2	mph
ATMOSPHERIC STABILITY CLASS	=	F	
LIQUID CONFINEMENT AREA	=	NONE	
VAPOR/GAS DISCHARGE HEIGHT	=	0	feet

KEY RESULTS PROVIDED BY USER INSTEAD OF BY EVALUATION METHODS

AMOUNT DISCHARGED	=	4208	lbs

KEY RESULTS OVERRIDDEN BY USER AT SOME POINT AFTER COMPUTATION

EVAPORATING POOL AREA	=	2441	ft2

HAZARDOUS MATERIAL = Nitric Acid
ADDRESS \ LOCATION = Hanford
LATITUDE = 117
LONGITUDE = 46
DATE OF ASSESSMENT = 1/1/93
NAME OF DISK FILE = LOC1.ASF

*** SCENARIO DESCRIPTION

Case 6: Spill of 100 gallons Nitric Acid
Spill area of 100 ft2
Acid temperature 80 F

******* LIQUID POOL SIZE ESTIMATES

Evaporating pool area = 2441 ft2

******* LIQUID POOL EVAPORATION RATE/DURATION ESTIMATES

Vapor evolution rate = 2.28 lbs/min
Evolution duration = 1850.6 minutes

******* TOXIC VAPOR DISPERSION ANALYSIS RESULTS

Downwind distance to concentration of 2 ppm
-- at groundlevel = 6177 feet

Note: Minimum computable answer is 33 feet!
Actual hazard distance may be less.

See attached table(s) for further details.

Case 7

IDLH = 100 ppm

exp. limit = 2 ppm (offsite low hazard criteria ERPG-1)

15 ppm (onsite low hazard criteria ERPG-2)

TOXIC VAPOR DISPERSION ANALYSIS RESULTS

Downwind Distance (feet)	Downwind Distance (miles)	Groundlevel Concentration (ppm)	Source Height Concentration (ppm)	Initial Evacuation Zone Width* (feet)
100	.02	2708	2708	110
535	.11	113	113	420
969	.19	39.6	39.6	740
1403	.27	21.1	21.1	1050
1837	.35	13.5	13.5	1370
2271	.43	9.6	9.6	1690
2705	.52	7.2	7.2	2000
3139	.6	5.7	5.7	2320
3573	.68	4.7	4.7	2630
4007	.76	3.9	3.9	2950
4441	.85	3.3	3.3	3270
4875	.93	2.9	2.9	3580
5309	1.01	2.6	2.6	3900
5743	1.09	2.3	2.3	4210
6177	1.17	2	2	1

6.4

= 16.5 mg/m3

Loc got 12 mg/m3

*Usually safe for < 1 hour release. Longer releases or sudden wind shifts may require a larger width or different direction for the evacuation zone. See Chapters 3 and 12 of the guide for details. Source height specified by the user for this scenario was 0 feet.

TOXIC VAPOR DISPERSION ANALYSIS RESULTS

Downwind Distance (feet)	Downwind Distance (miles)	Contaminant Arrival Time at Downwind Location (minutes)	Contaminant Departure Time at Downwind Location (minutes)
100	.02	.6	1851.8
535	.11	3.1	1856.7
969	.19	5.6	1861.7
1403	.27	8	1866.6
1837	.35	10.5	1871.5
2271	.43	13	1876.5
2705	.52	15.4	1881.4
3139	.6	17.9	1886.3
3573	.68	20.4	1891.3
4007	.76	22.8	1896.2
4441	.85	25.3	1901.1
4875	.93	27.7	1906
5309	1.01	30.2	1911
5743	1.09	32.7	1915.9
6177	1.17	35.1	1920.8

CAUTION: See guide for assumptions used in estimating these times.

INPUT PARAMETER SUMMARY

PHYSIOCHEMICAL PROPERTIES OF MATERIAL			
NORMAL BOILING POINT	=	183	degrees F
MOLECULAR WEIGHT	=	63	
LIQUID SPECIFIC GRAVITY	=	1.4216	
VAPOR PRES AT AMBIENT TEMP 100°F	=	.152 .164	psia
	=	7.813	mm Hg
TOXIC VAPOR LIMIT	=	2	ppm
CONTAINER CHARACTERISTICS			
TEMP OF CONTAINER CONTENTS	=	80	degrees F
ENVIRONMENTAL/LOCATION CHARACTERISTICS			
AMBIENT TEMPERATURE	=	100	degrees F
WIND VELOCITY	=	2	mph
ATMOSPHERIC STABILITY CLASS	=	F	
LIQUID CONFINEMENT AREA	=	NONE	
VAPOR/GAS DISCHARGE HEIGHT	=	0	feet
KEY RESULTS PROVIDED BY USER INSTEAD OF BY EVALUATION METHODS			
DISCHARGE RATE	=	25200	lb/min
DURATION DISCHARGE	=	.167	minutes
AMOUNT DISCHARGED	=	4208.4	lbs

KEY RESULTS OVERRIDDEN BY USER AT SOME POINT AFTER COMPUTATION

NONE OBSERVED

$$\left(2.28\ \frac{lb}{min}\right)\left(\frac{4.54\times10^{5}\ mg}{lb}\right)\left(\frac{1\ min}{60\ s}\right)\left(8.3\times10^{-4}\ \frac{s}{m^3}\right) = \boxed{14.3\ \frac{mg}{m^3}}$$

$$\left(2.24\times10^{-4}\ \frac{s}{m^3}\right) = \boxed{3.9\ \frac{mg}{m^3}}$$

assuming 5th power law Pm. over 31 hrs.

HEDOP REVIEW CHECKLIST
for
Radiological and Nonradiological Release Calculations

Loc V. Nguyen, "GENII DOSE CONSEQUENCE CALCULATIONS IN SUPPORT OF SAFETY ANALYSIS FOR THE 222-S LABORATORY," October 18, 1993.

Submitted by: L. V. Nguyen. Date Submitted: October 18, 1993

Scope of Review: Entire Document

YES	NO*	N/A		
[X]	[ ]	[ ]	1.	A detailed technical review and approval of the environmental transport and dose calculation portion of the analysis has been performed and documented.
[ ]	[X]	[ ]	2.	Detailed technical review(s) and approval(s) of scenario and release determinations have been performed and documented.
[X]	[ ]	[ ]	3.	HEDOP-approved code(s) were used.
[ ]	[ ]	[X]	4.	Receptor locations were selected according to HEDOP recommendations.
[X]	[ ]	[ ]	5.	All applicable environmental pathways and code options were included and are appropriate for the calculations.
[X]	[ ]	[ ]	6.	Hanford site data were used.
[ ]	[ ]	[X]	7.	Model adjustments external to the computer program were justified and performed correctly.
[X]	[ ]	[ ]	8.	The analysis is consistent with HEDOP recommendations.
[ ]		[X]	9.	Supporting notes, calculations, comments, comment resolutions, or other information is attached. (Use the "Page 1 of X" page numbering format and sign and date each added page.)
[X]	[ ]		10.	**Approval is granted on behalf of the Hanford Environmental Dose Overview Panel.**

* All "NO" responses must be explained and use of nonstandard methods justified.

D.A. Himes [signature] 10/19/93
HEDOP-Approved Reviewer (Printed Name and Signature) Date

COMMENTS (add additional signed and dated pages if necessary):

scenarios + releases specified by customer

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222-S Interim Safety Basis/YLF21		ECN No.

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